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**Productivity, Efficiency and Technical Change:
Measuring the Performance of China's Transforming Agriculture**

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Abstract

As China enters the 21st century the health of the agricultural economy will increasingly rely, not on the growth of inputs, but on the growth of total factor productivity (TFP). However, the tremendous changes in the sector—sometimes back and sometimes forwards—as well as evolving institutions make it difficult to gauge from casual observation if the sector is healthy or not. Research spending has waxed and waned. Policies to encourage the import of foreign technologies have been applied unevenly. Structural adjustment policies also triggered wrenching changes in the sector. Horticulture and livestock production has boomed; while the output of other crops, such as rice, wheat and soybeans, has stagnated or fallen. At a time when China's millions of producers are faced with complex decisions, the extension system is crumbling and farmer professional associations remain in their infancy. In short, there are just as many reasons to be optimistic about the productivity trends in agriculture as to be pessimistic.

In this paper, we pursue one overall goal: to better understand the productivity trends in China's agricultural sector during the reform era—with an emphasis on the 1990 to 2004 period. To do so, we pursue three specific objectives. First, relying on the National Cost of Production Data Set—China's most complete set of farm input and output data—we chart the input and output trends for 23 of China's main farm commodities. Second, using a stochastic production frontier function approach we estimate the rate of change in TFP for each commodity. Finally, we decompose the changes in TFP into two components: changes in efficiency and changes in technical change.

Our findings—especially after the early 1990s are remarkably consistent. China's agricultural TFP has grown at a healthy rate for all 23 commodities. TFP growth for the staple commodities generally rose around 2 percent annually; TFP growth for most horticulture and livestock commodities was even higher (between 3 and 5 percent). Equally consistent, we find that most of the change is accounted for by technical change. The analysis is consistent with the conclusion that new technologies have pushed out the production functions, since technical change accounts for most of the rise in TFP. In the case of many of the commodities, however, the efficiency of producers—that is, the average distance of producers from the production frontier—has fallen. In other words, China's TFP growth would have been even higher had the efficiency of production not eroded the gains of technical change. Although we do not pinpoint the source of rising inefficiency, the results are consistent with a story that there is considerable disequilibrium in the farm economy during this period of rapid structural change and farmers are getting little help in making these adjustments from the extension system.

Productivity, Efficiency and Technical Change: Measuring the Performance of China's Transforming Agriculture

During the early reform period there are few scholars that question the positive role that agriculture played in the economy and sources of the large rises of food and fiber (Rozelle et al., 2005). Based in part on the incentives embodied in the Household Responsibility System, farm output and productivity grew by 5 to 10 percent between 1978 and 1985 (McMillan, Whalley and Zhu, 1989; Lin, 1992). Huang and Rozelle (1996) Fan and Pardey (1997) show that better incentives were enhanced by new technologies. Inputs also rose as farmers had greater access to fertilizer and other farm inputs (Stone, 1988) and improved water control, especially due to the emergence of groundwater (Nickum, 1998; Wang, 2005).

During the mid-1990s, at a time when China's rapid growth was becoming recognized as a transformative force of people's livelihood, another debate rose about whether China could feed itself. Brown (1994) among others pointed out that the level of input use was already high in China and that future growth would rely of total factor productivity (TFP) growth. The pessimist (e.g., Wen, 1993) suggested that TFP had stopped growing and that China's farming sector was unhealthy. In response, several efforts (e.g., Fan,1997; Jin et al., 2002) used more rigorous methods and showed that while aggregated inputs had indeed stopped growing (as labor shifted off the farm; sown area was stagnant), output continued to grow resulting in positive TFP growth, which was a respectable rate of around 2 percent per year. Although there were many challenges facing the agricultural economy as China entered the end of the 1990s, it was shown that the investment into R&D (which because of time lags between investment and production

of new varieties had taken place in the late 1970s and 1980s) was producing the technology that was driving TFP.

Somewhat surprisingly in recent years there has been almost no work done to continue to monitor the health of China's agricultural economy. According to our reading of the literature, there are no papers that use high quality nationwide input and output to rigorously measure shifts in productivity. In contrast, in other countries there are annual efforts to track changes in productivity.

The lack of information on TFP is all the more surprising since as China enters the 21st century the health of the agricultural economy will increasingly rely, not on the growth of inputs, but on the growth of total factor productivity (TFP). There are tremendous changes in the sector—sometimes back and sometimes forwards—as well as evolving institutions which make it difficult to gauge from casual observation if the sector is healthy or not. Research spending has waxed and waned (Hu, 2007). Policies to encourage the import of foreign technologies have been applied unevenly (Pray et al., 1997). Structural adjustment policies also triggered wrenching changes in the sector (Rosen et al., 2004). Horticulture and livestock production has boomed; while the output of other crops, such as rice, wheat and soybeans, has stagnated or fallen (CNBS, 2005). At a time when China's millions of producers are faced with complex decisions, the extension system is crumbling and farmer professional associations remain in their infancy (Huang et al., 2003). In short, there are just as many reasons to be optimistic about the productivity trends in agriculture as to be pessimistic. Yet, there is no where in the literature to turn to understand the trends in productivity over the past 15 years.

Because of this absence of information, the overall goal of this paper is to better understand the productivity trends in China's agricultural sector during the reform era—with an emphasis on the 1990 to 2004 period. To do so, we pursue three specific objectives. First, relying on the National Cost of Production Data Set—China's most complete set of farm input and output data—we chart the input and output trends for 23 of China's main farm commodities. Second, using a stochastic production frontier function approach we estimate the rate of change in TFP for each commodity. Finally, we decompose the changes in TFP into two components: changes in efficiency and changes in technical change.

Because this already is an ambitious paper, we necessarily must limit the scope of the analysis. Specifically, we exam the major staple grains and oilseeds, cotton, several vegetable and fruit crops and most of the major livestock commodities. In total, the commodities that are covered accounted for more than 65 percent of China's gross value of agricultural output in 2005 (CNBS, 2006). However, due to the lack of data and time, we do not estimate TFP growth for several major commodities, including aquaculture, sugar, edible oils beyond soybeans and many fruits, vegetables and more minor livestock commodities. In addition, we measure the productivity shifts on a commodity by commodity basis. As shown in deBrauw et al. (2004) and Lin (1992), if the rise of specialization in China is occurring (as is reported in the literature—Rozelle et al., 2007) and this results in the positive allocative efficiency gains, our approach underestimates the rise in productivity in China's farming sector. We also ignore regional differences in productivity, even though our results are done on a province by province basis and aggregated to a national total.

To meet our objectives the rest of the paper is organized as follows. In the following sections we first present a brief review of our methodology. Next, we discuss the data. The following section contains a brief review of recent changes in China's agriculture and how these might be expected to affect TFP. Understanding these trends will be helpful in interpreting the results. TFP growth results and their decomposition are then presented for the 23 commodities. The final section concludes.

Methodology

Traditional studies of productivity growth in agriculture have tended to compute productivity as a residual after accounting for input growth, and to interpret the growth in productivity as the contribution of technical progress. Such an interpretation implies that improvements in productivity can arise only from technical progress. However this assumption is valid only if firms are technically efficient, thus operating on their production frontiers and realizing the full potential of the technology. The fact is that for various reasons firms do not operate on their frontiers but somewhere below them, and TFP measured in this way can reflect both technological innovation and changes in efficiency. Therefore technical progress may not be the only source of total productivity growth, and it will be possible to increase factor productivity through improving the method of application of the given technology – that is, by improving technical efficiency.

To study production efficiency, the stochastic frontier production function (Aigner, Lovell and Schmidt, 1977; Meeusen and van den Broeck, 1977) has been the subject of considerable recent research with regard to both extensions and applications (Battese and Coelli, 1995). Stochastic production function analysis postulates the

existence of technical inefficiency of production of firms involved in producing a particular output, which reflects the fact that many firms do not operate on their frontiers but somewhere below them. Many theoretical and empirical studies on production efficiency/inefficiency have used stochastic frontier production analysis (e.g., Coelli, Rao and Battese, 1998; Kumbhakar and Lovell, 2000).

As panel data permit a richer specification of technical change and obviously contain more information about a particular firm than does a cross-section of the data, recent development of techniques for measuring productive efficiency over time has focused on the use of panel data (Kumbhakar, Heshmati and Hjalmarsson, 1999; Henderson, 2003). Panel data also allow the relaxation of some of the strong assumptions that are related to efficiency measurement in the cross-sectional framework (Schmidt and Sickles, 1984). In the rest of the paper, we adopt a panel data approach to measure and decompose TFP for our 23 commodities.

As in Kumbhakar (2000), the stochastic frontier production function for panel data can be expressed as:

$$(1) \quad y_{it} = f(x_{it}, t) \exp(v_{it} - u_{it})$$

where y_{it} is the output of the i th firm ($i = 1, 2, \dots, N$) in period t ($t = 1, 2, \dots, T$); $f(\cdot)$ is the production technology; x is a vector of J inputs; t is the time trend variable; v_{it} is assumed to be an iid $N(0, \sigma_v^2)$ random variable, independently distributed of the u_{it} ; and u_{it} is a non-negative random variable and output-oriented technical inefficiency term.

There are several specifications that make the technical inefficiency term u_{it} time-varying, but most of them have not explicitly formulated a model for these technical inefficiency effects in terms of appropriate explanatory variables.¹ Battese and Coelli

(1995) proposed a specification for the technical inefficiency effect in the stochastic frontier production function as:

$$(2) \quad u_{it} = z_{it}\delta + w_{it}$$

where the random variable w_{it} is defined by the truncation of the normal distribution with zero mean and variance σ^2 , such that the point of truncation is $-z_{it}\delta$, i.e., $w_{it} \geq -z_{it}\delta$.

As a result, u_{it} is obtained by truncation at zero of the normal distribution with mean $z_{it}\delta$ and variance σ^2 . The normal assumption that the u_{it} s and v_{it} s are independently distributed for all $i = 1, 2, \dots, N$ and $t = 1, 2, \dots, T$ is obviously a simplifying but restrictive condition.

Technical inefficiency, u_{it} , measures the proportion by which actual output, y_{it} , falls short of maximum possible output or frontier output $f(x, t)$. Therefore technical efficiency (TE) can be defined by:

$$(3) \quad TE_{it} = y_{it} / f(x_{it}, t) = \exp(-u_{it}) \leq 1$$

Time is included as a regressor in the frontier production function and used to capture trends in productivity change – popularly known as exogenous technical change and is measured by the log derivative of the stochastic frontier production function with respect to time (Kumbhakar, 2000). That is, technical change (TC) is defined as:

$$(4) \quad TC_{it} = \frac{\partial \ln f(x_{it}, t)}{\partial t}$$

Productivity change can be measured by the change in TFP and is defined as:

$$(5) \quad TFP_{it} = y_{it} - \sum_j S_{jit} x_{jit}$$

where S_{jit} is the cost-share of the j th input for the i th firm at time t . Kumbhakar (2000) has shown that the overall productivity change can be decomposed by differentiating equation (1) totally and using the definition of TFP change in equation (5). This results in a decomposition of the TFP change into 4 components: a scale effect, pure technical change, technical efficiency change and the input price allocative effect. In this study, we are holding scale effects and allocative efficiency effects constant.

Data

Historically estimates of China's cropping TFP have been controversial, arriving at significantly different conclusions. Poor data and ad hoc weights may account for the debates and uncertainty over pre- and post- reform productivity studies. Researchers gleaned data from a variety of sources; they warn readers of the poor quality of many of the input and output series (Stone and Rozelle, 1995).

Data and Methodology for Creating TFP Measures

In this paper, we overcome some of the shortcomings of the earlier literatures by taking advantage of data that have been collected for the past 25 years by the State Price Bureau. Using a sampling framework with more than 20,000 households, enumerators collect data on the costs of production of all of China's major crops. The data set contains information on quantities and total expenditures of all major inputs, as well as expenditure on a large number of miscellaneous costs. Each farmer also reports output and the total revenues earned from the crop. Provincial surveys by the same unit supply unit costs for labor that reflect the opportunity cost of the daily wage foregone by farmers that work in cropping. During the last several years, these data have been published by

the State Development and Planning Commission (“The Compiled Materials of Costs and Profits of Agricultural Products of China”, SPB, 1988-2004). The data have previously been used in analyses on China’s agricultural supply and input demand (Huang and Rozelle, 1996; Huang, Rosegrant, and Rozelle, 1996; World Bank, 1997; Jin et al., 2002).

In this paper, we attempt to examine the record of TFP for a large cross section of China’s most important commodities. Because of this and in order to provide continuity with previous studies that mostly examined grain crops, we also examine rice, wheat and maize. Because the characteristics of major types of rice vary so much across space and over time, we provide separate TFP analyses for early and late Indica varieties (or long grain rice) and for Japonica varieties (short/medium grain rice). We also examine the productivity trends of China’s largest non-grain staple crop—soybeans and cotton.

The rise of China as a major horticulture producer (and exporter) and its clear comparative advantage in producing labor intensive farm commodities have made us include four vegetables (capsicum; eggplant, cucumbers and tomatoes) and two fruit crop (mandarin oranges and regular oranges). Lack of data preclude including any more. Because cucumbers and tomatoes are grown in large quantities both in the field and in greenhouses, we examine TFP separately for these two crops.

The increasing importance of livestock commodities in China and the prospect for even greater increases demands that we examine changes in TFP for major livestock commodities. Therefore, the study examines TFP growth for hogs, egg, beef cattle and dairy. Because of the radical differences in the technologies used in China’s backyard, specialized household and commercial sectors, in the analysis of TFP in the livestock sector, we examine productivity separately for backyard hog production, production by

specialized households (those raising relatively large numbers of hogs) and commercial hog producers (called state and collective-owned farms). We also examine production of eggs for both specialized household and commercial producers. The TFP analysis for beef cattle is focused on aggregate production only since the data on backyard, specialized household and commercial producers are not available. Finally, we examine the changes in TFP of two types of dairy producers—specialized household milk producers and the commercial producers.

Data for the livestock sector was particularly problematic for a number of reasons. Because of this, we had to employ a number of assumptions and external pieces of information to create consistent and empirical sensible data series at the province level. These adjustments are described in detail in Appendix I. Adjustments were also needed for dairy. These are described in Appendix II and Ma et al. (2006).

While this is an invaluable data set and matches that needs of the methodology described in the previous section, there are several limitations. First, because of China's grain-first mentality in the 1980s, coverage of non-grain crops is extremely spotty in the 1980s. Because of this we can only produce TFP estimates in the 1980s for rice, wheat, maize, soybeans and cotton. All of the rest of the commodities are reported for 1990 to 2003 or 2004. Second, because of data availability by province we necessarily had to use unbalanced panel methods. The list of coverage (number of provinces and number of years) for each commodity is in Appendix III.

We have to limit our attention to major agricultural commodities. The major agricultural commodities that are included in our study still account for more than 62% of total gross agricultural value (excluding forestry and fishery) during the period of 2000-

2005. The difficulties of getting data for other commodities prevent us from including them in the study.

Economic Forces, Structural Change and Productivity

Three major forces are likely to be affecting the growth of TFP of China's major agricultural commodities: a.) investment in R&D through China's domestic agricultural research system and the availability through other channel to new technologies; b.) the performance of the agricultural extension system; and c.) other economic forces that will push farmers into and out of different agricultural commodities, methods of production (e.g., in the backyard or in commercial lots) and technologies (e.g., greenhouses, etc.). The strength of the various forces (or lack thereof) will determine if productivity has been enhanced or limited by increasing or decreasing efficiency or by increasing or decreasing technical change. The final magnitude of the growth or contraction of total factor productivity is decided by the sum of changes in efficiency and changes in technical change.

Technology Development

After the 1960s, China's research institutions grew rapidly, from almost nothing in the 1950s, to a system that now produces a steady flow of new varieties and other technologies. China's farmers used semi-dwarf varieties several years before the release of Green Revolution technology elsewhere. China was the first country to develop and extend hybrid rice. Chinese-bred conventional rice varieties, wheat, and sweet potatoes were comparable to the best in the world in the pre-reform era (Stone, 1988).

Agricultural research and plant breeding in China is almost completely organized by the government (Huang et al., 2003—the book). Reflecting the urban bias of food policy, most crop breeding programs have emphasized fine grains (rice and wheat) until the 1990s. For national food security consideration, high yields have been major target of China's research program except for recent years when the quality improvement was introduced into the nation's development plan. In recent years, however, there has been more effort focused on breeding for horticulture and livestock.

A nationwide reform in research was launched in the mid-1980s (Pray et al., 1997). The reforms attempted to increase research productivity by shifting funding from institutional support to competitive grants, supporting research useful for economic development, and encouraging applied research institutes to support themselves by selling the technology they produce. In addition, in the late 1980s and early 1990s, imports of new horticultural seeds, genetics for improvement of the nation's livestock inventories (Rae et al., 2006) and new technologies for dairy (Ma et al., 2006).

After waning for more than a decade (between the early 1980s and mid-1990s—Pray et al., 1997), investment into R&D finally began to rise. Funding was greatly increased for plant biotechnology, although only Bt cotton has been commercialized in a major way (Huang et al., 2002). Since 1995 investment by the government into R&D increased by 5.5 percent annually between 1995 and 2000 and by more than 15 percent annually after 2000 (Hu et al., 2007).

Extension system

If spending on the agricultural research system is best characterized as a U-shaped curve and is a system that has had a modicum of success in reform, the extension system

is best considered a long, downward sloping slide and is characterized by few, if any, major successes. At its peak, the extension system in China was one of the most effective in the developing world. A public funded system, there were extension agents at the county and township level. From above, they were supported by ties in a provincial research system which also had experiment stations in almost every prefecture. From below, communes during the Socialist era and villages after reform appointed one or more representatives from the village to be a liaison between the farmers and the extension system.

After the mid-1980s, however, fiscal pressures at all levels of government induced local officials to try to commercialize the extension system. Although there have been differences over time and across space, in most localities commercialization was attempted by partially privatizing the position of extension agent (Park and Rozelle, 1998). In return for working part of their time doing traditional extension activities, extension agents were allowed to go into business, most often selling seeds, fertilizer and pesticides. The profits from their business activities were supposed to cross subsidize their extension activities. At the most extension agents found their salaries reduced by half or more. In many areas, payments were completely stopped and they were expected to continue to do their extension duties while at the same time be a business person.

As might be expected, because of difficulties in monitoring and the incentives to spend most or all of their time on their income earning activities, the extension system went into a period of near disintegration. Surveys found that most farmers rarely, if ever, saw extension agents. In other work, it has been documented that extension agents were overselling pesticides, and providing farmers with inaccurate information when the

emergence of new technologies (e.g., Bt cotton seeds) conflicted with their business practices (sales of pesticides—Huang et al., 2003). It has even been documented empirically, that the greater the extension effort, the lower the productivity (Jin et al., 2002). A recent survey of dairy, livestock and horticulture farmers found that there was little if any support for these activities from the formal extension system (which is still staffed with agronomists trained during the grain-first years of China's agricultural policy).

Other forces

There are other economic forces that should be expected to affect the nation's productivity. First, and above, all since the structural adjustment policies and the acceleration of China's growth in the late 1990s, there has been a veritable tidal wave of change. China's agricultural economy has steadily been remaking itself from a grain-first sector to one producing higher valued cash crops, horticultural goods and livestock/aquaculture products. In the early reform period, output growth—driven by increases in yields—was experienced in all subsectors of agriculture, including grains. For example, between 1978 and 1984, grain production, in general, increased by 4.7 percent per year. Production rose for each of the major grains—rice, wheat and maize. However, after the mid-1990s, with the exception of maize that is now almost exclusively used for feed, rice and wheat sown area and production have fallen. Although this may concern old-time grain fundamentalist inside China, in fact, the fall in supply of grain has been led by the collapse in demand, as rising incomes in urban and rural areas, migration and marketization has pushed people away from grains into alternative crops.

Like the grain sector, cash crops, in general, and specific crops, such as cotton, edible oils and vegetables and fruit, also grew rapidly in the early reform period when compared to the 1970s. Unlike grain (with the exception of land-intensive staples, such as cotton), the growth of the non-grain sector continued throughout the reform era. Moreover, the rise in some sectors has been so fast that it almost defies description. For example, between 1990 and 2004 the increase in vegetable production capacity has been so fast that China as a nation is adding the equivalent of the production capacity of California (the world's most productive vegetable basket) every two years. When compared on the basis of the share of cultivated area dedicated to fruit orchards, the share in China (over 5 percent) is more than double the share of the next closest major agricultural nation (including the US, the EU, Japan, India). China today can more closely be said to following "taking cucumbers and oranges as the key link" than being a grain-first agriculture as in the Socialist era.

China also is moving rapidly away from a cropping agricultural mentality. The rise of livestock and fishery sectors outpaces the cropping sector, in general, and most of the subcategories of cropping. Livestock production rose 9.1 percent in the early reform period and has continued to grow at between 4.5 to 8.8 percent since 1985. The fisheries subsector is the fastest growing component of agriculture, rising more than 10 percent per year in 1985-2000. Today, more than 70 percent of the world's fresh water aquaculture is produced in China. And, the rapid and continuous rise in livestock and fisheries has steadily eroded the predominance of cropping. After remaining fairly static during the Socialist era, the share of agriculture contributed by cropping fell from 76 percent to 51 percent between 1980 and 2005. At the same time, the combined share of livestock and

fisheries rose to 45 percent, more than doubling their 1980 share (only 20 percent). It is projected that by 2008, cropping will account for less than 50 percent of agricultural output in China. Dairy demand is also rising extremely rapidly (Fuller et al., 2006).

Simultaneous with these changes, China has also experienced an explosion of market-oriented activities (Rozelle et al., 2000). While the policies were gradual, throughout the 1980s and 1990s, the role of the state in China's markets has diminished. In its place there has been a rise of private traders and wholesale markets staffed by private traders that today has given China one of the most efficient sets of markets in the world (Huang et al., 2004). Deep and competitive markets also have been documented for the emerging horticultural sector (Wang et al., 2006). Dairy, livestock and other commodities also are characterized by competitive markets.

Expected effects on TFP

Exante it is difficult to assess how China's investment into agricultural R&D and other shifts in policies affecting the availability of technology; changes in the extension system and other economic forces have affected total factor productivity. The effect of any one of these forces depends on the direction of the change and its magnitude. Unfortunately, it is difficult to quantify these forces and formally decompose the change in TFP into its component sources. Additional complexity is added because some of the changes will affect efficiency and others will affect technical change.

However, stepping back there are some forces for which we have a fairly good intuitive idea about the direction of the impact. For example, the deterioration of the extension system almost certainly will have had a negative effect on TFP and would mainly affect the efficiency of farming by not teaching farmers how to use the newly

available technologies. In contrast, the new regulations for the importation of genetics, horticultural varieties and dairy technology and the rise of markets that make these available to farmers should promote TFP through the rise of technical change.

However, the effect of other forces is more difficult to predict. Will the falling R&D investment in the 1980s and 1990s show up as falling technical change (especially in the case of grains)? Will the continued restrictions on the investment into agricultural R&D for the major grains limit the pace of technical change? At the same time, better incentives through research reform and better scientific inputs should raise TFP through its positive influence on technical change. Hence, for agricultural R&D, in particular, and for the effect of all economic forces, in general, the final word on how the health of the agricultural economy has fared is an empirical one.

Inputs, Outputs and Productivity—Before 1995

After the extremely fast growth in output and fall in inputs (mostly labor that shifted to sidelines and other off farm activities) that was documented in early 1980s during the implementation of the Household Responsibility System (McMillan, Whalley and Zhu, 1989; Lin, 1992), leaders became concerned with the pace of the growth of output during the subsequent decade. In fact, our data contain traces of evidence that the concerns were justified in the case of some crops but not others. Table 1 demonstrates that between 1985 and 1994 the growth rate of output of early and late indica rice, japonica and soybeans fell to below 1 percent (column 1). The growth of early indica rice was almost zero. While zero growth rates are not always bad from a productivity point of view (since inputs could be falling faster), in the case of these four crops, inputs actually

rose faster, at an annual rate of 1 to 2 percent. At least for these crops, it is clear why officials were concerned about productivity.

However, in the case of other staple grain crops—wheat and maize—there is less room for concern. Although in no way close to the rates of increase that were enjoyed before 1985, between 1985 and 1994 output for wheat and maize rose to 2 percent annually. During this time inputs for these two crops rose, albeit at a slower rate (on average—for the three crops—about 2 percent).

While data are less available for crops beyond grain and soybeans before the mid-1990s, the record of output and input trends also is mixed (Tables 2 and 3, columns 1 and 2). The seriousness of nearly uncontrollable outbreaks of cotton pests can be seen through the fall of output (-0.49 percent annually) and sharp rises in inputs (more than 4 percent—mostly for labor and materials for pest control). The rate rise of inputs used in hog production also rose faster than output. Therefore, the concerns that the output to input mix in agriculture extended beyond traditional staple crops at least had some basis. The case of beef, however, shows that output was still rising much faster than inputs in other sectors.

TFP Performance before 1995

TFP analysis demonstrates that, while the concern for low TFP growth in China during the 1985-1994 decade is real, reliance on output and input trends can sometimes be somewhat misleading (Tables 4, columns 1 to 3). Perhaps due to smoothing across years (the output and input growth rates were generated by using linear trends in the input and output series) using our methodology for analyzing TFP, early and late indica rice and soybeans, in fact, show a modest rate of gain of TFP during the late 1980s and early

1990s (about 1 percent annually, on average). Wheat and maize are also positive (although the increase is small). In contrast, japonica rice registered a fall in TFP between 1985 and 1994 (-0.12 percent annually).

The sources of growth—which can also not be identified using descriptive statistics and trend analysis—also vary among the crops. Positive technological change (albeit less than 2 percent annually in all cases) were behind the TFP rises for early and late indica rice and contributed about half of the rise of maize TFP. In contrast, some or all of the modest rises in TFP for wheat, maize and soybeans can be accounted for by increased efficiencies. While we can not identify the exact reason by there was a measured rise in the efficiency of production, these rates of increase are consistent with the measurements of deBrauw et al (2004) which shows that the gradual liberalization of China's grain markets after 1985 generated efficiency gains for producers.

The record is mixed for non-grain crops. The fall in cotton TFP (Table 5, columns 1 to 3) shows that China's cotton production sector was indeed in danger of becoming uncompetitive during the 1985-1994 decade (as described in Qiao et al., 2007). Although the research system helped stem the fall by producing some new conventional cotton varieties, the efficiency of production fell (likely due to the uncontrolled rise in the large volume of pesticides that appeared on the market to control the emergence of the cotton bollworm population that was becoming increasingly resistant to conventional pesticides). Some of the new pesticides, however, appear to not have been effective (meaning for a given level of input the output fell short of the production frontier—which by definition is measured as inefficiency). While the story of hog production TFP is largely the same (it is driven by rises in new technology), the importance of using our analytical approach

is clear since it shows that TFP, in fact, rose between 1985 and 1994, unlike the story told by the raw output/input trends.

The Record of TFP Growth: 1995 to 2004

Entering the last half of the 1990s, our analysis of the period between 1985 and 1994 shows that the concerns of the world about the health of China's agricultural economy were not unfounded. There were some crops for which TFP growth was positive. However, for others TFP was falling or largely stagnant. Even optimists must have been sobered by the fact that on average TFP growth was below 2 percent per year (a rate often thought to be an indicator of a healthy agricultural sector). The fears of pessimists were further fueled by the deceleration of the growth of TFP. If the growth rates of the 1985-1994 decade were so much lower than the growth rates in the pre-1985 period, it was naturally to be worried that the TFP rates of growth during the period after 1995 could even be lower. There also was such a lack of information on many of the rapidly emerging crops and agricultural commodities (e.g., horticultural crops and poultry and dairy) during the pre-1995 period due to the absence of data. The analysis in this section seeks to address these concerns.

Outputs and Inputs after 1995

Unlike the decade before 1995, during the 10 year period between 1995 and 2004 output and input trends showed remarkable improvement and consistency (Tables 1 to 3, columns 3 and 4). Of the 23 commodities for which we have complete output and input data during this period, in the case of 20 of them the rate of growth of outputs exceeds

that of inputs. In particular, the rate of growth of output of all grains and soybeans outpace that of inputs.

There are also positive signs of a healthy agriculture outside the conventional grain economy. The recovery of China's cotton industry is shown by the remarkable turn around in annual output (+2.68 percent) and input (-1.90 percent) trends. No doubt the widespread emergence of Bt cotton—which allowed farmers to dramatically reduce pesticide use (and labor for spraying) while increasing yields—is a large part of the story. In the case of livestock, except for the specialized milk sector (that is mostly made up of large commercial dairies), the annual rate of rise of output of all commodities is greater than that of inputs.

Only in the horticultural sector is the record more mixed. The growth rate of output of five of the horticultural crops (capsicum; field cucumbers; greenhouse cucumbers; greenhouse tomatoes; and mandarin oranges) exceeds the growth rate of inputs. However, the opposite is true for eggplant, field tomatoes and conventional oranges.

TFP and its Sources, 1995-2004

The TFP analysis after 1995 tells an even more positive story in general about the health of China's agriculture than the output and input trends and demonstrates a sharp resurgence when compared to the 1985-1994 decade (Table 4 to 6, columns 4 to 6). Using the stochastic production frontier methods (described above—and used in the previous section), the rate of TFP growth for all 23 commodities—including grains, soybean, cotton, horticultural crops and livestock commodities—were all positive. Moreover, with the exception of maize (1.70 percent), capsicum (1.86 percent),

specialized milk producing households (0.48) and commercial dairies (1.31 percent), the annual growth rate of all commodities were in excess of 2 percent. In fact, using the value of output as rough weights and aggregating across all of the included commodities, the overall annual TFP growth rate of China's agriculture between 1995 and 2004 exceed 3 percent. When averaged with the growth rates during the 1978-1984 period and 1985-1995 period, between 1978 and 2004, China's agricultural TFP growth rate is likely to have been in excess of 3 percent annually, a rate that is remarkable for any country for such an extended period of time (Jin et al., 2002).

Rising Technical Change. The results also are consistent between the 1980s/early 1990s and late 1990s/2000s with regards to the sources of growth; technical change is driving the rise in productivity and is the foundation of the health of China's economy. When examining the source of grain and soybean TFP change (Table 4), technical change accounts for nearly all the rise for all crops except wheat (which accounts for half of TFP; while efficiency accounts for the other half). This finding is consistent with the findings of Jin et al. (2002) that found during the pre-1995 period, all of the positive change in TFP between the early 1980s and mid-1990s could be attributed to technological change. While we can not identify the exact source of technical change, the findings are consistent with the findings reported in Jin et al. (2002) that the new varieties that China's breeders were producing in the nation's breeding program during the 1980s (which were shown to have greater yield potential, among other new traits) were making their way into the fields of farmers.

The rise of technical change-based TFP growth in cotton and horticultural crops after 1995 (Table 5, columns 4-6) not only shows the effectiveness of China's domestic

breeding programs (especially in the case of Bt cotton from the Chinese Academy of Agricultural Sciences), it also suggests that opening China to the import of new varieties from outside of China is an effective way to improve technology and TFP. Because China's officials allowed foreign varieties of Bt cotton to be commercialized, farmers have benefited from having access to a productivity-increasing, foreign-produced technology (Huang et al., 2002). Our interviews in the horticultural industry likewise suggest that the large share of the measured rise in TFP that is due to technical change is from new varieties that were allowed to be imported from abroad. Since the early 1990s, horticultural seed industry traders told us that they faced few barriers in importing horticultural seed from Europe, Japan or the United States. During our household interviews during two large household surveys of vegetable traders in 2005 and 2006 we found that more than half of the varieties of horticultural crops had names that were clearly foreign in origin. Farmers told us that the varieties were both higher yielding and produced higher quality fruits and vegetables.

Imported technology and rising research effort into livestock between 1995 and 2004 also is likely to be behind the rapid rise of technical change-based TFP in the livestock sector (Table 6, columns 4 to 6). During the 1990s China encouraged the importation of large amounts of new genetic material for the hog, beef, poultry and dairy industries. Discussions with officials—from both inside and outside of China—suggest that new hog varieties from the US and Japan; new beef and dairy cattle genetics from Canada, New Zealand and Australia; and poultry technology from around the world, including the US, have greatly increased the genetic quality of China's livestock industry.

Apparently these new innovations have penetrated into China's villages and fledgling commercial sectors as technical change is shown to have risen sharply.

Falling Efficiency. But while the results are consistent with the positive effect of rising access to new technologies and improved genetics, they also expose some serious weaknesses in China's agriculture. In the case of more than half of our study's commodities (14 of 23), TFP would have been higher had not producers become less efficient during the study period, 1995 to 2004. In the case of maize, soybean, cotton, seven of the eight horticultural crops (all but greenhouse cucumbers) and half of the livestock commodities (specialized and commercial hog producers; and specialized and commercial dairies), producers were less efficient in 2004 than they were in 1995.

While the analysis can not identify the precise source of the fall in efficiency, we believe that there are two sources—one that may not be addressable by policy; the other which may be. It is interesting to note that perhaps with the exception of soybeans, all of the crops that have suffered falls in efficiency are those that have experienced rapid expansion since 1995. Maize, almost all horticultural crops and the specialized and commercial segments of the livestock industries have all grown much faster than the gross value of agricultural output in general; in other words, their share in the economy is expanding. Therefore, one perhaps unavoidable source of rising inefficiency is due to the expected disequilibrium that accompanies the rapid expansion of any crop (or other industrial product). New producers are adopting new crops and they require time to learn how to produce the crop and market it effectively. As expansion occurs for crops, often times the new cultivated area is displacing cultivated area of other crops and the new area may be relatively less favorable. This would, of course, lead to a fall in the measured

efficiency of the sector. Hence, some of this fall is perhaps unavoidable and will continue as long as the share of the crop is expanding.

However, it is likely that another part of the fall in efficiency that is avoidable is occurring due to the deterioration of the extension system. As discussed above, China's extension system has steadily eroded during the reform era, and a part of this has occurred after 1995. Especially given three factors—the nature of China's farming sector (which is almost all made up of extremely small farms (CNBS, 2005); the absence of cooperation (Shen et al., 2006); and the rapid rise of technology (which, as discussed immediately above, is responsible for the rise in China's TFP)—the nation needs a strong extension system. Yet, at the very time extension services are needed, they are disappearing. Therefore, it is perhaps unsurprising that in 14 of the 23 commodities production is becoming more inefficient and in all of the rest the contribution of efficiency is zero or far below the contribution of technical change.

Conclusions

Our findings in this paper about the record of TFP growth in China are remarkably consistent—especially after 1995 (the main focus of our paper). Our analysis shows that China's agricultural TFP has grown at a healthy rate for all 23 commodities. TFP growth for the staple commodities generally rose around 2 percent annually; TFP growth for most horticulture and livestock commodities was even higher (between 3 and 5 percent). This rise in TFP is high by both historic and international standards and demonstrates the healthiness of China's economy.

Equally consistent, we find that most of the change is accounted for by technical change. The analysis is consistent with the conclusion that new technologies have pushed out the production functions, since technical change accounts for most of the rise in TFP. In the case of many of the commodities, however, the efficiency of producers—that is, the average distance of producers from the production frontier—has fallen. In other words, China's TFP growth would have been even higher had the efficiency of production not eroded the gains of technical change.

Although we do not pinpoint the source of rising inefficiency, the results are consistent with a story that there is considerable disequilibrium in the farm economy during this period of rapid structural change. Hence, our paper, more than anything, establishes a basis for China's (and international) leaders and policy makers who are committed to keeping a strong agricultural supply capacity to confidently invest in the nation's agricultural research system and to open up trade channels to allow for the importation of new technologies. The basis for doing so primarily rest on the importance that technology and the institutions that create, import and spread it has had on TFP in the past. TFP has continued to rise after 1995 primarily due to past contributions of technology.

However, our analysis also identified a possible weakness in China's agriculture. Although part of the measured fall in efficiency in many of the crops may be due to the disequilibrium that may naturally occur during the expansion phase of a crop, it also is clear that farmers are getting little help in making these adjustments from the extension system. If anything (due to the rise in importance of new technology), it is a time that China's extension system should be built up. Many factors—fiscal; administrative; etc.—

are behind the deterioration of China's extension system. One of the biggest challenges for China's officials, of course, is to combat this fall. If they can do this, recapturing the recent fall in efficiency it could be another source of productivity rise in the coming years.

Appendix I: Details on the Data Used for the Livestock TFP Analysis

An ongoing problem for the study of livestock productivity in China is obtaining accurate data. The majority of studies of Chinese agricultural productivity have used data published in China's Statistical Yearbook. While this source disaggregates gross value of agricultural output into crops, animal husbandry, forestry, fishing and sideline activities, input use is not disaggregated by sector. A major improvement we introduce is to utilise additional data collected at the farm level that will allow the construction of time-series of input use by the livestock farm type. A further problem with livestock data from the statistical yearbooks is the apparent over-reporting of both livestock product output and livestock numbers (Fuller, Hayes and Smith, ERS). This problem also needs to be addressed if the possibility of biased livestock productivity estimates is to be avoided.

We specify four inputs to livestock production - breeding animal inventories, labor, feed and non-livestock capital. We describe below the construction of data series for these livestock production inputs, as well as our approach to overcoming the over-reporting of animal numbers and outputs.

Livestock Commodity Outputs

Concerns over the accuracy of official published livestock data include an increasing discrepancy over time between supply and consumption figures and a lack of consistency between livestock output data and that on feed availability. Ma, Huang and Rozelle (2004—henceforth MHR) have provided adjusted series for livestock production (and consumption) that are internally consistent by recognizing that the published data do contain valid, albeit somewhat distorted information. In order to adjust the published series, new information from several sources is introduced. Specifically, MHR use the 1997 national census of agriculture as a baseline to provide an accurate estimate of the size of China's livestock economy in at least one time period. The census is assumed to provide the most accurate measure of the livestock economy since it covers all rural households and non-household agricultural enterprises. The census also collected information on the number of slaughterings (by type) during the 1996 calendar year. A second source of additional information is the official annual survey of rural household income and expenditure (HIES) that is run by the China National Bureau of Statistics (CNBS). Information collected in that survey includes the number of livestock slaughtered and the quantity of meat produced for swine, poultry, beef cattle, sheep and goats, and eggs. MHR assumes the production data as published in the Statistical Yearbook to be accurate from 1980-1986. Beyond this date, that data are adjusted to both reflect the annual variation as found in the HIES data and to agree with the Census data for 1996. Further details of the adjustment procedure can be found in MHR. The adjusted series includes provincial data on livestock production, inventories and slaughterings.

Animals as Capital Inputs

Following Jarvis we recognize the inventory of breeding animals as a major capital input to livestock production. Thus opening inventories of sows, milking cows,

laying hens and female yellow cattle are used as capital inputs in the production functions for pork, milk, eggs and beef respectively. Provincial inventory data for sows, milking cows and female yellow cattle are taken from official sources and adjusted for possible over-reporting as described above.

Additional problems exist with poultry inventories. China's yearbooks and other statistical publications contain poultry inventories aggregated over both layers and broilers. No official statistical sources publish separate data for layers. Ma, Huang and Rozelle (2004), however, provide adjusted data on egg production, and the State Development Planning Commission's agricultural commodity cost and return survey provided estimates of egg yields per hundred birds. Thus layer inventories, at both the national and provincial levels, are calculated by dividing output by yield.ⁱⁱ A simple test shows that the sum across provinces of our provincial layer inventories is close to our estimate of the national layer inventory in each year.ⁱⁱⁱ

Feed, Labor and Non-livestock Capital Inputs

Provincial data for these production inputs are obtained directly from the Agricultural Commodity Cost and Return Survey.^{iv} Thought to be the most comprehensive source of information for agricultural production in China, the data have been used in many other studies (e.g., Huang and Rozelle, 1996; Jin et al., 2002). Within each province a three-stage random sampling procedure is used to select sample counties, villages and finally individual production units. Samples are stratified by income levels at each stage. The cost and return data collected from individual farms (including traditional backyard households, specialized households, state- and collective-owned farms and other larger commercial operations) are aggregated to the provincial and national level datasets that are published by the State Development Planning Commission.

The survey provides detailed cost items for all major animal commodities, including those covered in this paper. These data included labor inputs (days), feed consumption (grain equivalent) and fixed asset depreciation on a 'per animal unit' basis. We deflate the depreciation data using a fixed asset price index. We calculate total feed, labor and non-livestock capital inputs by multiplying the input per animal by animal numbers. For the latter, we use our slaughter numbers for hogs and beef cattle, and the opening inventories for milking cows and layers since these are the 'animal units' used in the cost survey. It is clear that this procedure, necessitated by the available data, excludes some input usage, such as that by other animal categories within the pig and cattle herds.

Livestock Production Structures

China's livestock sector is experiencing a rapid evolution in production structure, with potentially large performance differences across farm types. For example, traditional backyard producers utilize readily available low-cost feedstuffs, while specialized households and commercial enterprises feed more grain and protein meal. The trend from traditional backyard to specialized household and commercial enterprises in livestock production systems therefore implies an increasing demand for grain feed (Fuller, Tuan

and Wailes, 2002). To estimate productivity growth by farm type, our data must be disaggregated to that level. This is not a problem for the feed, labor and non-livestock capital variables, since they are recorded by production structure in the cost surveys. However, complete data series on livestock output and animal inventories by farm type do not exist.

Our approach to generating output data by farm type is to first construct provincial ‘share sheets’ that contained time series data on the share of animal inventories (dairy cows and layers) and slaughterings (hogs) by each farm category (backyard, specialized and commercial).^v Inventories of sows by farm type are then generated by multiplying the aggregate totals (see earlier section) by the relevant farm-type hog slaughter share. We note that this assumes a constant slaughterings-to-inventory share across farm types for hog production, and therefore assumes away a possible cause of productivity differences in this dimension across farm types. However, it proved impossible to gather further data to address this concern.

To disaggregate our adjusted livestock output data by farm type, it is important to take into account yield differences across production structures. From the cost surveys we obtained provincial time-series data on average production levels per animal (eggs per layer, milk per cow and mean slaughter liveweights for hogs). Such information is then combined with the farm-type data on cow and layer inventories and hog slaughterings to produce total output estimates by farm type that were subject to further adjustment so as to be consistent with the aggregate adjusted output data.

Information that allows us to estimate the inventory and slaughter shares by farm type and by province over time comes from a wide variety of sources. These include the 1997 China Agricultural Census, China’s Livestock Statistics, a range of published materials (such as annual reports, authority speeches and specific livestock surveys) from various published sources, and provincial statistical websites. The census publications provide an accurate picture of the livestock production structure in 1996 (Somwaru, Zhang and Tuan, 2003). However, the census defines just two types of livestock farms - rural households and agricultural enterprises (including state- and collective-owned farms). We interpret the latter as ‘commercial’ units, but additional information is used to disaggregate the rural households into backyard and specialized units. Agricultural Statistical Yearbooks and China’s Livestock Statistics provide data on livestock production structure during the early 1980s, when backyard production and state farms were prevalent. These sources, plus the Animal Husbandry Yearbooks and provincial statistical websites also provide estimates of livestock shares for various livestock types, provinces and years. When all these data are combined with 1996 values from the census, many missing values still existed. On the assumption that declining backyard production and increasing shares of specialized and commercial operations are gradual processes that evolved over the study period, linear interpolations are made to estimate a number of missing values.

Appendix II. Details on the Data Used for the Dairy Sector TFP Analysis

Since dairy sector official statistics face the same over-reporting problem as described in Appendix I and the data adjustments for dairy sector were not included in Ma, Huang and Rozelle (2004), we have to adjust data on milk output and dairy cattle inventories before estimating dairy sector TFP. To maintain the consistency with the livestock commodities, we use a similar approach to adjust milk output and the dairy cattle numbers. In order to adjust the published series, new information from several sources is introduced.

First, the 1997 national census of agriculture is used as a baseline to provide an accurate estimate of the size of China's dairy sector economy in at least one time period. As described in Ma, Huang and Rozelle (2004), the census is assumed to provide the most accurate measure of dairy cattle inventory in 1996 since it covers all rural households and non-household agricultural enterprises.

Second, we also used the official annual survey of rural household income and expenditure (HIES) that is run by the China National Bureau of Statistics (CNBS). Information collected in that survey includes the numbers of cow milk output.

We also assume that the dairy cattle numbers and milk output data as published in the Statistical Yearbook are accurate from 1980-1986. Beyond this date, we assume that the data are adjusted to both reflect the annual variation as found in the HIES data and to agree with the Census data for 1996.

The adjustment procedure for dairy sector production data is the same as described in Ma, Huang and Rozelle (2004). The adjusted series includes provincial data on dairy cattle inventory and milk output.

Appendix III. The Information on Sample Size

Commodity	Time periods covered	Min no. of provinces per year	Max no. of provinces per year	Total observations
Hogs				
Backyard households	1980-2001	15	27	491
Specialised households	1980-2001	3	25	285
Commercial	1980-2001	2	25	224
Layers				
Specialised households	1991-2001	10	22	160
Commercial	1991-2001	8	16	132
Beef				
Rural households	1989-2001	4	10	97
Milk				
Specialised households	1992-2001	5	16	91
Commercial	1992-2001	10	23	155
Crops				
Corn	1985-2004	19	22	418
Wheat	1985-2004	21	25	459
Early rice	1985-2004	7	11	179
Late rice	1985-2004	4	9	155
Japonic	1985-2004	14	17	313
Soybean	1985-2004	13	18	302
Cotton	1985-2004	14	17	308
Horticulture				
Capsicum	1990-2003	6	28	260
Eggplant	1990-2003	12	28	306
Field cucumber	1990-2003	10	26	266
Field tomato	1990-2003	9	25	259
Greenhouse cucumber	1990-2003	6	21	186
Greenhouse tomato	1990-2003	5	20	193
Mandarin orange	1990-2003	2	6	118
Orange	1990-2003	3	11	160

Note: vegetables cover only urban areas of provincial capital cities.

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Table 1. Annual growth rate (%) of yield and total cost of main grain crop in China, 1985 to 2004.

Crop	1985-1994		1995-2004	
	Output	Input	Output	Input
Early Indica	0.05	1.72	0.08	-2.31
Late Indica	1.37	2.12	0.80	-1.16
Japonica	1.79	3.99	0.17	-1.99
Wheat	2.84	2.58	1.38	-0.22
Maize	3.66	1.87	1.04	-0.63
Soybean	0.71	2.24	1.06	-1.36

Data source: National Agricultural Production Cost Survey (see data section for complete description). See appendices for complete annual series of cost of production at national level.

Growth rates generated by regression method.

Table 2. Annual growth rate (%) of yield and total cost of cash crops (cotton and horticultural crops) in China, 1985 to 2004.

Crop	1985-1994		1995-2004	
	Output	Total cost	Output	Total cost
Cotton	-0.49	4.60	2.68	-1.90
Horticultural crops				
Capsicum	n.a.	n.a.	2.87	2.22
Eggplant	n.a.	n.a.	1.47	2.90
Field Cucumber	n.a.	n.a.	-0.40	-1.79
Field Tomato	n.a.	n.a.	1.36	1.94
Greenhouse Cucumber	n.a.	n.a.	1.11	0.60
Greenhouse tomato	n.a.	n.a.	2.95	1.50
Mandarin Orange	n.a.	n.a.	1.30	0.13
Orange	n.a.	n.a.	-1.77	0.30

Data source: National Agricultural Production Cost Survey (see data section for complete description). See appendices for complete annual series of cost of production at national level.

Growth rates generated by regression method.

Table 3. Annual growth rate (%) of output and total cost of livestock and dairy production in China, 1985 to 2004.

Commodities	1985-1994		Early or mid-90s - 2004*	
	Output	Total cost	Output	Total cost
Backyard Hog Production	1.24	2.47	5.29	-5.12
Specialized Hog Production	3.80	5.53	5.54	-5.37
Commercial Hog Production	0.29	0.86	13.05	-4.60
Specialized Egg Production	n.a.	n.a.	1.95	-1.87
Commercial Egg Production	n.a.	n.a.	2.43	-0.57
Beef Production	10.2	-1.29	9.30	-0.92
Specialized Milk	n.a.	n.a.	2.02	3.21
Commercial Milk	n.a.	n.a.	5.19	0.71

Data source: National Agricultural Production Cost Survey (see data section for complete description). See appendices for complete annual series of cost of production at national level.

Growth rates generated by regression method.

Table 4. Annual Growth Rate (%) of Main Grain Crops's Total Factor Productivity (TFP) and Decomposition into Technical Efficiency (TE) and Technical Change (TC) in China, 1985 to 2004.

	1985-1994			1995-2004		
	TFP	TE	TC	TFP	TE	TC
Early Indica	1.84	-0.03	1.88	2.82	0	2.82
Late Indica	1.85	0.26	1.59	2.92	0.21	2.71
Japonica	-0.12	-0.37	0.26	2.52	0.15	2.37
Wheat	0.25	1.08	-0.83	2.16	1.06	1.10
Maize	1.03	0.61	0.42	1.70	-0.23	1.94
Soybean	0.11	0.19	-0.09	2.27	-0.08	2.35

Table 5. Annual growth (%) of Cash Crops' (Cotton and Horticultural Crops) Total Factor Productivity (TFP) and Decomposition of TFP into Technical Efficiency (TE) and Technical Change (TC) in China, 1985 to 2004.

	Growth rate (1980s-1990s)			Growth rate (1990/91-2003)		
	TFP	TE	TC	TFP	TE	TC
Cotton	-0.34	-2.54	2.21	4.16	-3.47	7.63
Horticultural Crops						
Capsicum	n.a.	n.a.	n.a.	1.86	-0.42	2.28
Eggplant	n.a.	n.a.	n.a.	2.24	-3.14	5.37
Field Cucumber	n.a.	n.a.	n.a.	5.15	-1.27	6.42
Field Tomato	n.a.	n.a.	n.a.	3.23	-0.50	3.73
Greenhouse Cucumber	n.a.	n.a.	n.a.	5.86	0.62	5.24
Greenhouse tomato	n.a.	n.a.	n.a.	4.02	-2.43	6.45
Mandarin Orange	n.a.	n.a.	n.a.	2.33	-2.19	4.52
Orange	n.a.	n.a.	n.a.	4.31	-3.20	7.50

Table 6. Annual growth (%) of Livestock and Dairy Products' Total Factor Productivity (TFP) and Decomposition into Technical Efficiency (TE) and Technical Change (TC) in China, 1985 to 2004.

Products	Growth rate (1980s-1990s)			Growth rate (1990/91-2003)		
	TFP	TE	TC	TFP	TE	TC
Backyard Hog Production	4.80	1.26	3.54	3.72	1.01	2.72
Specialized Hog Production	5.58	-0.14	5.72	5.35	-0.72	6.07
Commercial Hog Production	5.67	0.09	5.58	4.40	-0.38	4.78
Specialized Egg Production	n.a	n.a	n.a	3.78	0.32	3.46
Commercial Egg Production	n.a	n.a	n.a	4.83	1.44	3.39
Beef Production	n.a	n.a	n.a	4.41	0.01	4.40
Specialized Milk	n.a	n.a	n.a	0.48	-6.09	6.58
Commercial Milk	n.a	n.a	n.a	1.31	-3.26	4.57

Appendix Tables: Cost of production (all the cost figures are in 1985 real term)

Appendix Table 1: Yield, Total Cost and Major Cost Shares for **Corn** Production in China

Year	Yield (kg/mu)	Output per man day (kg)	Total Production Cost (yuan/ton)	Of Total Cost (%)				Of Total Material Input Cost (%)					
				Labour Input	Materials Input	Seeds Input	Organic Manure	Fertilizer Use	Plastic Sheet	Pestici des	Irrigati on	Fence	Deprec iation
1985	297	18	192	43.0	57.0	9.7	19.0	33.4	0.0	0.8	3.2	0.0	7.7
1986	311	19	178	41.2	58.8	10.3	10.0	38.6	0.0	1.4	3.9	0.0	7.8
1987	310	19	207	44.4	55.6	11.3	13.1	34.0	0.0	0.9	3.5	0.0	7.0
1988	313	19	198	43.2	56.8	10.1	12.6	36.4	0.0	1.0	3.2	0.0	7.6
1989	166	10	391	41.9	58.1	9.4	12.5	36.5	1.7	1.0	3.9	0.0	7.3
1990	358	21	200	42.5	57.5	12.2	11.8	38.1	2.5	1.6	2.8	0.0	6.1
1991	354	24	183	38.2	61.8	10.4	9.7	37.5	2.3	1.5	4.7	0.0	7.0
1992	351	21	198	44.0	56.0	10.3	8.9	38.4	3.5	2.0	4.3	0.0	7.3
1993	421	56	139	37.6	62.4	10.6	8.3	40.5	3.6	2.0	3.7	0.0	8.2
1994	367	25	199	41.8	58.2	12.3	6.4	39.6	1.5	2.4	5.7	0.0	6.7
1995	362	23	229	41.5	58.5	13.3	7.9	42.9	1.5	2.7	4.1	0.0	11.3
1996	381	24	232	45.3	54.7	13.4	7.8	43.8	2.4	2.4	4.3	0.0	10.6
1997	350	22	263	48.2	51.8	10.8	7.6	40.9	2.2	2.4	7.9	0.0	10.8
1998	384	27	219	47.8	52.2	11.8	8.5	43.9	2.7	3.0	5.7	0.0	7.9
1999	363	28	224	46.8	53.2	12.0	8.0	42.9	2.2	2.9	7.6	0.0	7.6
2000	351	28	226	47.3	52.7	11.1	7.3	41.9	1.8	3.0	8.3	0.0	6.6
2001	379	31	209	48.3	51.7	11.3	8.2	40.5	2.2	3.2	8.4	0.0	6.0
2002	393	34	206	46.2	53.8	14.6	7.4	40.7	1.8	3.3	6.7	0.0	5.8
2003	369	33	218	47.4	52.6	12.6	7.6	42.6	1.9	3.3	6.6	0.0	5.6
2004	424	42	205	46.4	53.6	12.8	6.6	46.0	1.1	3.5	5.7	0.1	4.7

Source: National Agricultural Production Cost Survey.

Appendix Table 2: Yield, Total Cost and Major Cost Shares for **Wheat** Production in China

Year	Yield (kg/mu)	Output per man day (kg)	Total Production Cost (yuan/ton)	Of Total Cost (%)				Of Total Material Input Cost (%)					
				Labour Input	Materials Input	Seeds Input	Organic Manure	Fertilizer Use	Plastic Sheet	Pestici des	Irrigati on	Fence	Deprec iation
1985	208	15	283	35.0	65.0	17.3	14.4	31.8	0.0	1.4	4.1	0.0	7.0
1986	203	15	313	39.8	60.2	18.1	14.1	31.1	0.0	1.5	5.0	0.0	6.6
1987	197	15	333	39.5	60.5	17.5	14.0	30.8	0.0	1.8	4.8	0.0	6.4
1988	215	16	301	40.0	60.0	16.7	14.1	31.0	0.0	1.7	4.9	0.0	6.6
1989	230	16	292	37.7	62.3	17.1	11.0	32.9	0.0	2.3	5.3	0.0	6.3
1990	217	17	312	33.6	66.4	17.9	10.1	34.7	0.0	2.8	4.5	0.0	5.5
1991	233	19	299	34.8	65.2	15.8	10.1	35.5	0.1	3.3	4.7	0.0	5.8
1992	256	20	298	38.5	61.5	14.8	9.0	34.8	0.1	3.3	6.3	0.0	6.0
1993	244	20	327	42.9	57.1	13.7	8.0	33.9	0.1	3.3	6.4	0.0	6.9
1994	153	6	365	13.5	86.5	15.0	7.3	34.6	0.1	3.0	7.2	0.0	6.4
1995	257	20	297	39.9	60.1	18.5	7.9	38.3	0.1	3.1	7.2	0.0	6.6
1996	261	21	338	39.5	60.5	18.0	7.1	40.0	0.4	3.8	7.3	0.0	5.4
1997	277	23	323	42.0	58.0	17.8	6.6	37.9	0.4	3.2	7.2	0.0	5.7
1998	246	23	337	40.3	59.7	17.1	6.9	38.4	0.6	3.3	8.2	0.0	6.1
1999	261	25	325	39.5	60.5	16.8	6.9	37.2	0.1	3.7	10.2	0.0	6.4
2000	261	27	310	37.5	62.5	15.6	5.7	34.1	0.1	3.2	10.5	0.0	5.5
2001	261	28	303	39.5	60.5	15.6	6.1	32.8	0.1	3.1	9.9	0.0	5.4
2002	262	28	311	39.7	60.3	15.2	6.1	34.4	0.1	3.6	10.0	0.0	5.3
2003	255	28	312	40.2	59.8	15.2	6.4	34.3	0.0	3.5	9.7	0.0	5.5
2004	340	42	251	37.8	62.2	14.0	5.9	36.3	0.0	3.7	9.4	1.1	2.4

Source: National Agricultural Production Cost Survey.

Appendix Table 3: Yield, Total Cost and Major Cost Shares for **Early Indica** Production in China

Year	Yield (kg/mu)	Output per man day (kg)	Total Production Cost (yuan/ton)	Of Total Cost (%)				Of Total Material Input Cost (%)					
				Labour Input	Materials Input	Seeds Input	Organic Manure	Fertilizer Use	Plastic Sheet	Pestici des	Irrigati on	Fence	Deprec iation
1985	375	18	205	41.1	58.9	9.8	9.0	37.0	0.0	5.4	5.6	0.0	8.1
1986	372	18	195	39.8	60.2	10.1	9.0	37.1	0.0	5.3	5.3	0.0	8.2
1987	359	18	222	43.1	56.9	10.1	8.9	36.5	0.0	6.4	5.0	0.0	8.0
1988	351	18	230	39.3	60.7	9.0	9.5	39.0	0.0	6.1	5.2	0.0	7.4
1989	370	19	230	37.2	62.8	10.8	8.2	36.6	1.6	6.7	3.5	0.1	6.8
1990	389	21	223	37.1	62.9	9.8	8.8	36.3	1.5	6.9	4.6	0.1	7.2
1991	356	18	242	37.9	62.1	9.4	9.7	36.4	1.9	6.3	4.4	0.1	7.6
1992	360	20	223	42.1	57.9	9.7	7.5	38.5	1.8	6.2	4.4	0.3	7.9
1993	379	21	219	43.0	57.0	8.7	6.5	40.8	1.9	6.0	5.0	0.1	7.2
1994	359	21	263	47.2	52.8	8.8	7.4	36.3	1.8	5.6	4.9	0.1	9.2
1995	366	21	302	46.2	53.8	10.8	5.9	40.3	1.8	6.6	3.4	0.2	7.3
1996	398	21	318	50.2	49.8	9.4	5.6	39.2	1.9	6.5	4.9	0.2	6.4
1997	384	23	317	50.1	49.9	8.2	5.5	35.8	2.1	6.8	4.2	0.2	6.8
1998	351	24	296	49.1	50.9	8.9	6.1	37.8	2.5	7.3	5.0	0.4	7.7
1999	353	26	286	48.5	51.5	8.8	4.5	37.0	2.2	7.7	4.7	0.9	6.9
2000	373	29	261	50.1	49.9	8.4	4.7	35.2	2.3	7.7	5.8	0.4	7.2
2001	375	30	260	50.8	49.2	7.8	4.9	34.9	2.0	7.9	6.0	0.2	7.5
2002	364	31	264	50.4	49.6	8.4	4.1	34.5	2.0	7.5	5.5	0.3	7.6
2003	371	31	261	51.5	48.5	8.3	3.6	35.5	1.8	8.2	4.9	0.2	7.2
2004	393	34	263	46.4	53.6	7.5	4.3	33.4	2.0	9.4	4.8	0.0	7.8

Source: National Agricultural Production Cost Survey.

Appendix Table 4: Yield, Total Cost and Major Cost Shares for **Late Indica** Production in China

Year	Yield (kg/mu)	Output per man day (kg)	Total Production Cost (yuan/ton)	Of Total Cost (%)				Of Total Material Input Cost (%)					
				Labour Input	Materials Input	Seeds Input	Organic Manure	Fertilizer Use	Plastic Sheet	Pestici des	Irrigati on	Fence	Deprec iation
1985	350	17	206	42.3	57.7	9.6	5.7	39.2	0.0	8.7	5.2	0.0	8.4
1986	333	16	213	41.2	58.8	9.2	5.9	40.3	0.0	7.7	3.7	0.0	9.1
1987	347	18	234	42.3	57.7	8.5	6.3	43.4	0.0	7.6	3.7	0.0	8.5
1988	315	16	269	38.0	62.0	7.7	6.3	43.5	0.0	8.6	3.6	0.0	8.0
1989	349	18	256	36.3	63.7	10.7	6.8	40.1	0.1	9.2	4.1	0.1	7.5
1990	374	19	235	39.4	60.6	10.2	6.1	37.6	0.0	10.0	4.6	0.3	7.6
1991	371	20	226	37.7	62.3	9.1	7.1	37.3	0.2	9.4	5.0	0.0	8.1
1992	364	20	229	41.2	58.8	9.0	6.4	37.7	0.1	8.9	4.4	0.0	9.6
1993	372	21	219	43.0	57.0	8.4	6.5	38.8	0.0	9.1	4.5	0.0	8.6
1994	356	21	259	43.6	56.4	9.7	6.1	36.6	0.0	8.4	4.9	0.3	8.8
1995	363	21	301	44.7	55.3	11.6	5.0	39.6	0.0	7.6	3.9	0.0	7.9
1996	361	21	317	50.7	49.3	9.7	4.6	40.4	0.1	8.8	4.2	0.0	7.9
1997	364	22	303	50.3	49.7	9.1	4.7	38.1	0.1	9.9	4.2	0.1	6.8
1998	380	26	264	49.9	50.1	9.2	5.0	37.5	0.3	9.8	4.6	0.0	9.4
1999	367	26	274	50.6	49.4	10.6	4.5	36.9	0.1	11.2	5.0	0.0	7.4
2000	365	28	266	50.8	49.2	9.3	4.4	35.3	0.1	11.1	6.0	0.1	7.0
2001	388	32	244	51.4	48.6	8.1	3.8	35.3	0.3	11.7	6.1	0.0	7.1
2002	370	31	231	46.2	53.8	9.3	3.8	35.5	0.2	11.1	5.0	0.0	7.5
2003	379	33	296	42.6	57.4	6.4	26.7	26.7	0.1	9.1	4.1	0.0	5.3
2004	398	35	265	43.9	56.1	7.6	3.9	36.2	0.3	12.6	5.3	0.0	6.7

Source: National Agricultural Production Cost Survey.

Appendix Table 5: Yield, Total Cost and Major Cost Shares for **Japonica** Production in China

Year	Yield (kg/mu)	Output per man day (kg)	Total Production Cost (yuan/ton)	Of Total Cost (%)				Of Total Material Input Cost (%)					
				Labour Input	Materials Input	Seeds Input	Organic Manure	Fertilizer Use	Plastic Sheet	Pestici des	Irrigati on	Fence	Deprec iation
1985	374	17	229	38.2	61.8	11.7	5.8	33.5	0.0	5.6	11.3	0.0	7.7
1986	419	19	196	36.9	63.1	12.3	5.3	30.4	0.0	6.8	11.0	0.0	8.0
1987	391	19	237	39.5	60.5	11.4	5.3	30.3	0.0	6.7	9.5	0.0	11.0
1988	406	19	220	38.7	61.3	11.6	6.0	34.2	0.0	7.4	11.4	0.0	2.7
1989	404	19	242	35.1	64.9	12.1	5.4	30.9	1.8	7.3	10.1	0.2	7.2
1990	435	21	234	32.9	67.1	12.0	5.3	31.0	2.0	7.2	10.1	0.3	6.1
1991	439	21	243	33.2	66.8	9.5	4.8	29.8	2.1	7.6	10.5	0.7	5.8
1992	435	22	249	33.9	66.1	10.1	4.6	28.9	2.6	6.9	10.2	0.6	6.3
1993	440	22	245	37.0	63.0	8.7	4.4	29.3	2.0	6.8	12.0	0.3	5.2
1994	449	23	280	37.2	62.8	9.4	4.2	29.1	1.9	7.2	13.1	0.5	5.0
1995	432	23	302	34.6	65.4	9.6	3.0	31.7	2.5	7.7	9.9	0.6	4.6
1996	463	24	305	38.4	61.6	10.4	4.8	31.1	2.1	6.9	9.6	0.3	4.7
1997	472	27	293	41.4	58.6	8.8	3.0	30.1	2.1	7.0	11.6	0.6	5.4
1998	722	55	157	37.5	62.5	7.9	3.9	31.7	2.4	8.4	15.4	0.5	5.6
1999	438	29	278	41.5	58.5	8.6	3.0	32.5	2.7	8.3	15.6	0.5	5.3
2000	451	30	258	44.3	55.7	8.1	2.9	30.4	2.1	8.6	17.0	0.4	5.6
2001	478	33	233	42.4	57.6	7.9	2.9	31.5	2.0	9.7	16.5	0.5	5.1
2002	482	36	233	39.9	60.1	7.8	3.4	30.0	2.0	8.9	19.0	0.6	5.6
2003	459	34	252	41.8	58.2	7.5	2.8	30.1	1.7	9.9	20.2	0.4	4.8
2004	507	49	235	37.6	62.4	6.6	2.8	32.9	1.8	11.3	13.8	0.1	4.5

Source: National Agricultural Production Cost Survey.

Appendix Table 6: Yield, Total Cost and Major Cost Shares for **Soybean** Production in China

Year	Yield (kg/mu)	Output per man day (kg)	Total Production Cost (yuan/ton)	Of Total Cost (%)				Of Total Material Input Cost (%)					
				Labour Input	Materials Input	Seeds Input	Organic Manure	Fertilizer Use	Plastic Sheet	Pestici des	Irrigati on	Fence	Deprec iation
1985	195	17	195	45.8	54.2	27.9	9.4	16.9	0.0	2.0	1.2	0.0	10.6
1986	199	17	183	44.3	55.7	30.1	5.7	18.7	0.0	1.7	1.7	0.0	10.5
1987	190	16	214	49.9	50.1	30.9	10.5	15.2	0.0	2.0	1.2	0.0	10.3
1988	191	16	211	46.8	53.2	30.3	8.9	17.3	0.0	2.3	1.4	0.0	9.9
1989	191	17	210	46.0	54.0	32.7	10.4	13.3	0.0	2.6	1.6	0.0	10.1
1990	201	17	216	48.5	51.5	30.1	10.0	17.8	0.0	2.8	0.8	0.0	9.6
1991	188	18	208	45.4	54.6	27.2	8.1	18.9	0.0	2.7	1.2	0.0	10.7
1992	191	18	219	48.0	52.0	30.3	8.4	20.2	0.2	3.7	1.7	0.0	8.8
1993	222	20	206	48.0	52.0	29.7	6.4	17.9	0.3	4.1	1.7	0.0	8.9
1994	217	20	208	49.6	50.4	26.2	6.4	22.1	0.3	4.3	3.5	0.0	8.5
1995	232	22	202	46.2	53.8	24.1	5.5	24.6	0.0	3.9	1.5	0.0	9.6
1996	242	21	236	48.8	51.2	25.5	6.6	24.5	0.0	3.6	1.9	0.0	7.5
1997	217	19	288	49.5	50.5	24.1	7.2	18.5	0.0	4.3	8.7	0.0	7.9
1998	258	28	184	54.3	45.7	29.9	8.4	25.3	0.0	5.2	5.3	0.0	13.6
1999	243	31	182	50.6	49.4	26.7	8.1	24.4	0.2	6.9	6.5	0.0	11.9
2000	242	33	181	46.8	53.2	26.1	4.2	21.1	0.0	7.1	5.2	0.0	9.8
2001	237	32	184	47.3	52.7	23.2	4.9	23.3	0.0	5.6	4.7	0.0	9.8
2002	267	37	165	48.4	51.6	23.1	4.0	24.2	0.0	6.8	6.1	0.0	10.2
2003	240	32	199	48.4	51.6	23.3	4.8	25.2	0.1	6.3	5.3	0.0	9.1
2004	260	50	201	40.7	59.3	21.1	1.9	27.4	0.0	8.2	1.6	0.2	7.9

Source: National Agricultural Production Cost Survey.

Appendix Table 7: Yield, Total Cost and Major Cost Shares for **Cotton** Production in China

Year	Yield (kg/mu)	Output per man day (kg)	Total Production Cost (yuan/ton)	Of Total Cost (%)				Of Total Material Input Cost (%)					
				Labour Input	Materials Input	Seeds Input	Organic Manure	Fertilizer Use	Plastic Sheet	Pestici des	Irrigati on	Fence	Deprec iation
1985	60	1.4	1978	53.8	46.2	6.2	17.2	29.1	0.0	11.9	3.4	0.0	7.6
1986	63	1.5	1744	52.2	47.8	6.5	15.8	29.4	0.0	12.0	4.2	0.0	7.3
1987	63	1.6	1979	54.8	45.2	6.8	12.8	30.7	0.0	12.1	3.8	0.0	6.9
1988	53	1.3	2325	53.7	46.3	6.3	11.8	30.6	0.0	15.6	3.9	0.0	7.0
1989	58	1.4	2207	51.5	48.5	6.6	12.0	30.0	0.0	22.0	3.8	0.0	5.6
1990	68	1.5	2145	53.5	46.5	6.3	11.8	29.5	5.5	18.2	3.3	0.5	6.6
1991	69	1.6	2188	49.8	50.2	5.8	9.3	28.9	6.5	17.7	4.8	0.4	6.1
1992	53	1.3	2867	50.7	49.3	5.1	8.9	28.8	7.2	20.4	5.1	0.3	5.1
1993	57	1.4	2667	53.1	46.9	5.9	8.5	29.4	7.3	20.2	4.8	0.3	5.0
1994	60	1.4	2942	56.9	43.1	5.9	7.7	30.6	6.2	21.2	5.1	0.3	5.0
1995	61	1.5	3006	54.2	45.8	6.0	7.9	32.5	6.0	21.7	4.6	0.2	4.5
1996	61	1.5	3312	60.8	39.2	6.1	8.2	34.9	6.4	18.5	5.0	0.3	4.6
1997	65	1.7	3111	60.9	39.1	6.5	5.7	33.5	6.4	18.2	7.3	0.2	4.2
1998	68	2.0	2732	58.4	41.6	6.9	7.6	30.7	6.7	19.9	7.0	0.3	4.6
1999	67	2.2	2495	57.5	42.5	8.2	7.4	33.4	6.2	17.4	8.1	0.2	4.7
2000	71	2.5	2265	57.7	42.3	8.3	7.0	33.9	6.4	17.7	8.2	0.2	4.8
2001	78	2.6	2070	58.6	41.4	9.5	6.4	33.1	7.1	16.6	8.7	0.2	4.4
2002	82	2.8	1995	58.9	41.1	9.6	5.5	36.4	6.2	15.4	9.7	0.1	4.4
2003	68	2.5	2425	56.3	43.7	10.1	6.2	35.1	6.9	15.6	9.1	0.1	4.3
2004	76	3.1	2350	56.9	43.1	11.6	5.0	37.9	6.9	12.1	8.3	0.0	5.5

Source: National Agricultural Production Cost Survey.

Appendix Table 8: Yield, Total Cost and Major Cost Shares for **Capsicum** Production

Year	Yield (kg/mu)	Output per man day (kg)	Total Production Cost (yuan/ton)	Of Total Cost (%)				Of Total Material Input Cost (%)					
				Labour Input	Materials Input	Seeds Input	Organic Manure	Fertilizer Use	Plastic Sheet	Pestici des	Irrigati on	Fence	Deprec iation
1990	1543.2	51.2	318.0	28.3	71.7	25.8	16.8	9.1	21.8	3.6	2.5	4.0	5.7
1991	1243.9	54.7	335.6	27.6	72.4	20.9	15.6	10.8	22.0	4.3	3.3	7.0	4.8
1992	1545.3	155.2	561.2	51.7	48.3	18.4	14.5	11.6	18.8	5.2	2.6	3.8	4.8
1993	1970.4	73.3	364.7	39.6	60.4	14.5	18.2	12.0	18.0	4.7	8.8	0.6	5.7
1994	1421.7	62.1	321.6	45.2	54.8	24.7	14.9	15.4	16.5	6.1	3.6	3.5	4.2
1995	1540.8	54.8	341.1	42.9	57.1	16.9	20.3	13.5	18.2	7.6	2.8	3.5	4.5
1996	1793.3	66.8	424.0	53.2	46.8	17.8	19.2	16.6	15.2	7.4	4.0	3.0	6.3
1997	1692.4	64.4	405.1	52.7	47.3	9.9	13.4	17.1	20.6	6.9	3.3	5.9	8.4
1998	2021.7	58.2	382.2	52.7	47.3	15.8	17.5	21.3	18.4	7.7	3.1	6.4	5.6
1999	2206.0	57.4	413.3	53.4	46.6	12.4	18.5	18.6	18.3	10.3	4.0	6.1	6.1
2000	1971.9	49.9	368.4	49.9	50.1	14.6	17.4	18.6	17.1	10.7	4.9	5.4	4.5
2001	2067.9	46.0	393.6	51.9	48.1	14.2	23.0	18.0	13.7	9.9	4.6	4.7	5.0
2002	2227.4	44.9	397.4	53.6	46.4	13.8	19.6	20.0	14.8	10.2	4.5	6.3	4.9
2003	2312.3	45.8	424.5	53.5	46.5	12.6	19.1	20.3	14.7	10.9	4.8	6.3	5.2
2004	2408.8	44.1	390.5	46.5	53.5	12.9	18.5	24.4	6.9	10.5	5.1	2.8	2.8

Source: National Agricultural Production Cost Survey.

Appendix Table 9: Yield, Total Cost and Major Cost Shares for **Eggplant** Production

Year	Yield (kg/mu)	Output per man day (kg)	Total Production Cost (yuan/ton)	Of Total Cost (%)				Of Total Material Input Cost (%)					
				Labour Input	Materials Input	Seeds Input	Organic Manure	Fertilizer Use	Plastic Sheet	Pestici des	Irrigati on	Fence	Deprec iation
1990	2573.4	60.0	289.6	36.4	63.6	16.8	17.9	12.7	19.9	5.3	5.0	2.8	7.0
1991	2132.4	54.1	279.0	32.9	67.1	13.2	16.8	12.3	21.7	4.5	5.2	4.0	6.5
1992	2602.5	67.0	320.6	39.1	60.9	16.4	16.6	12.1	14.5	12.4	3.1	2.5	7.8
1993	2288.5	60.5	270.8	44.0	56.0	15.8	17.0	13.1	14.3	4.9	6.1	0.9	8.8
1994	1998.1	65.0	317.2	48.4	51.6	18.0	16.8	12.1	17.4	5.6	3.6	3.2	6.5
1995	2382.6	78.6	398.8	54.5	45.5	14.0	18.8	17.4	16.9	7.0	3.6	2.6	6.6
1996	2514.0	53.9	350.6	53.3	46.7	15.9	18.0	21.3	11.2	5.9	4.6	4.9	6.8
1997	2620.5	62.3	389.3	54.2	45.8	11.1	18.4	19.5	16.3	7.4	3.8	5.1	5.1
1998	2782.5	56.0	382.4	52.7	47.3	9.7	22.7	19.1	19.7	6.8	2.9	5.7	5.7
1999	3258.4	63.2	431.9	56.9	43.1	11.2	21.9	20.7	16.7	6.8	4.0	4.9	6.5
2000	2887.6	53.1	361.1	55.9	44.1	11.4	17.0	22.7	18.3	9.7	4.7	4.4	5.1
2001	3256.0	51.5	409.1	57.4	42.6	10.9	18.7	24.8	12.7	11.9	4.5	4.2	5.3
2002	3320.9	45.6	399.3	55.9	44.1	9.2	16.7	23.4	14.3	11.8	5.0	6.7	5.5
2003	3239.7	46.9	423.7	55.9	44.1	9.1	19.6	23.6	15.0	10.6	3.9	6.7	5.8
2004	3503.5	46.1	391.2	47.5	53.3	8.8	16.5	25.6	6.1	10.8	4.7	3.4	3.5

Source: National Agricultural Production Cost Survey.

Appendix Table 10: Yield, Total Cost and Major Cost Shares for **Greenhouse Cucumber** Production

Year	Yield (kg/mu)	Output per man day (kg)	Total Production Cost (yuan/ton)	Of Total Cost (%)				Of Total Material Input Cost (%)					
				Labour Input	Materials Input	Seeds Input	Organic Manure	Fertilizer Use	Plastic Sheet	Pestici des	Irrigati on	Fence	Deprec iation
1990	4740.5	126.0	1,035.2	21.4	78.6	11.6	10.3	8.2	35.2	7.7	1.7	11.9	2.2
1991	4657.7	131.6	965.5	23.1	76.9	8.9	10.6	7.5	31.8	5.7	1.9	12.9	7.4
1992	3440.1	162.3	1,250.3	24.3	75.7	9.1	10.2	9.2	26.1	6.0	2.0	10.6	7.7
1993	3628.4	101.7	663.2	30.2	69.8	13.4	9.5	8.5	26.6	6.4	2.8	10.9	7.4
1994	3980.9	122.9	902.9	30.2	69.8	8.0	6.4	7.9	30.7	5.0	5.3	10.1	9.0
1995	4042.8	127.2	953.3	37.0	63.0	5.1	10.4	10.2	24.1	7.0	3.6	9.0	13.4
1996	4114.9	100.1	1,128.1	31.2	68.8	9.6	9.2	7.8	31.0	6.2	2.3	9.6	13.3
1997	4133.9	92.5	974.2	35.3	64.7	10.4	7.9	8.6	33.3	6.6	2.2	8.3	11.7
1998	4830.5	90.0	769.9	40.0	60.0	3.7	12.0	11.1	33.6	7.0	2.7	15.4	7.7
1999	4836.2	93.2	878.9	40.8	59.2	5.3	13.1	12.7	24.7	8.9	3.3	13.6	11.1
2000	4746.5	84.9	820.5	37.5	62.5	4.7	12.5	11.1	29.0	7.5	3.3	12.1	9.0
2001	4592.7	83.6	829.4	41.1	58.9	5.4	11.9	13.2	27.5	7.1	3.2	14.8	11.5
2002	4912.0	83.3	846.3	44.0	56.0	6.5	11.2	13.6	25.1	7.7	3.8	14.6	11.3
2003	4819.2	86.3	878.5	47.2	52.8	7.5	11.5	13.4	25.2	7.0	3.6	12.9	13.2
2004	4775.2	76.3	820.1	38.7	61.3	6.1	11.5	13.0	22.9	7.2	3.4	5.3	19.2

Source: National Agricultural Production Cost Survey.

Appendix Table 11: Yield, Total Cost and Major Cost Shares for **Greenhouse Tomato** Production

Year	Yield (kg/mu)	Output per man day (kg)	Total Production Cost (yuan/ton)	Of Total Cost (%)				Of Total Material Input Cost (%)					
				Labour Input	Materials Input	Seeds Input	Organic Manure	Fertilizer Use	Plastic Sheet	Pestici des	Irrigati on	Fence	Deprec iation
1990	4147.9	120.7	732.8	28.9	71.1	6.2	13.6	7.4	35.5	6.4	2.0	8.5	5.0
1991	4127.8	128.4	820.5	26.6	73.4	11.4	11.9	7.9	37.3	4.9	1.6	8.8	6.8
1992	4171.0	146.1	788.7	34.7	65.3	8.6	10.0	8.7	32.1	4.5	2.0	11.8	8.4
1993	4365.0	132.2	863.9	30.1	69.9	9.1	8.5	10.0	25.7	5.9	3.7	14.9	12.2
1994	3997.1	141.2	909.9	37.1	62.9	9.6	8.2	9.8	30.3	4.4	3.2	11.5	8.6
1995	4268.7	125.9	913.8	36.8	63.2	5.9	10.0	9.3	31.7	6.1	2.1	10.1	13.5
1996	4676.1	108.7	961.4	40.8	59.2	9.4	11.9	10.4	30.4	5.2	2.4	12.4	5.9
1997	4643.5	115.1	1,015.4	42.4	57.6	3.5	9.0	9.2	29.3	5.6	2.8	8.6	16.7
1998	4575.0	90.4	772.4	43.8	56.2	4.8	12.4	11.5	30.8	6.7	2.1	15.6	11.6
1999	4658.7	92.2	816.0	44.8	55.2	6.6	11.5	12.7	27.7	6.1	2.7	11.1	15.2
2000	4907.1	90.0	850.2	39.0	61.0	4.2	10.5	10.9	28.0	5.5	2.7	13.0	15.3
2001	5074.4	88.2	891.5	40.3	59.7	4.7	12.3	11.5	28.0	7.1	3.0	15.7	13.6
2002	4796.1	85.6	852.3	45.5	54.5	5.6	12.7	12.9	25.7	6.9	3.6	15.7	12.5
2003	4761.2	84.9	876.4	46.6	53.4	5.7	11.9	13.6	25.0	7.9	2.8	13.6	15.0
2004	5088.7	79.5	966.3	43.9	56.1	5.6	10.7	14.3	22.0	7.1	2.7	6.0	21.9

Source: National Agricultural Production Cost Survey.

Appendix Table 12: Yield, Total Cost and Major Cost Shares for **Filed Cucumber** Production

Year	Yield (kg/mu)	Output per man day (kg)	Total Production Cost (yuan/ton)	Of Total Cost (%)				Of Total Material Input Cost (%)					
				Labour Input	Materials Input	Seeds Input	Organic Manure	Fertilizer Use	Plastic Sheet	Pestici des	Irrigati on	Fence	Deprec iation
1990	2850.9	79.0	377.7	36.7	63.3	12.3	14.5	8.9	17.8	6.3	3.4	18.1	5.7
1991	2656.6	69.5	356.6	33.1	66.9	11.0	15.5	8.7	22.0	7.4	3.0	15.7	3.6
1992	2872.6	86.2	483.2	33.4	66.6	12.9	11.8	9.7	19.8	6.0	2.9	14.3	5.7
1993	2742.6	72.7	386.2	37.0	63.0	9.2	14.5	10.1	15.0	7.5	3.7	17.6	6.5
1994	2698.5	76.6	387.2	46.0	54.0	13.2	15.5	12.8	15.0	6.4	2.7	14.5	4.7
1995	2561.6	70.9	390.6	50.7	49.3	8.6	16.8	12.0	13.7	9.2	3.6	16.5	3.0
1996	2700.2	67.8	430.8	55.0	45.0	8.9	21.8	18.6	6.3	9.4	2.8	14.6	4.1
1997	2653.9	65.5	406.8	52.5	47.5	9.2	14.2	17.4	9.4	10.6	5.8	12.2	4.1
1998	2897.0	54.8	349.9	54.9	45.1	7.9	15.5	22.1	6.8	8.3	4.1	21.9	4.8
1999	3281.1	59.1	407.6	54.0	46.0	10.0	17.1	26.5	8.7	8.5	5.0	15.4	4.7
2000	3235.5	52.8	363.5	51.8	48.2	10.3	16.5	20.4	8.1	14.4	4.4	15.7	3.6
2001	3396.3	46.8	392.4	52.6	47.4	10.0	20.4	20.4	6.1	13.8	5.0	13.0	4.3
2002	3527.6	49.7	414.5	55.1	44.9	10.1	19.5	20.1	7.2	13.2	5.6	13.5	4.7
2003	3413.7	47.3	418.0	54.4	45.6	10.7	17.5	22.5	7.1	13.6	5.3	14.1	4.1
2004	3661.8	48.3	426.3	46.3	53.7	8.9	16.2	23.2	5.3	13.5	4.8	8.7	3.3

Source: National Agricultural Production Cost Survey.

Appendix Table 13: Yield, Total Cost and Major Cost Shares for **Field Tomato** Production

Year	Yield (kg/mu)	Output per man day (kg)	Total Production Cost (yuan/ton)	Of Total Cost (%)				Of Total Material Input Cost (%)					
				Labour Input	Materials Input	Seeds Input	Organic Manure	Fertilizer Use	Plastic Sheet	Pestici des	Irrigati on	Fence	Deprec iation
1990	2841.2	84.7	397.2	37.4	62.6	18.0	11.6	8.2	26.8	4.8	2.3	11.4	6.4
1991	2504.7	68.7	331.1	35.2	64.8	14.9	16.1	9.9	21.9	4.6	3.3	13.4	5.0
1992	3342.3	83.4	426.6	36.6	63.4	12.0	15.1	12.4	21.3	7.8	2.2	10.1	4.4
1993	2804.8	91.0	427.7	41.9	58.1	13.9	15.7	9.9	19.7	5.3	3.1	9.2	5.2
1994	3062.0	85.7	387.5	49.3	50.7	12.8	13.6	13.8	15.3	7.0	2.8	10.4	5.8
1995	3001.3	78.6	448.2	46.3	53.7	13.0	15.4	19.2	9.8	7.9	2.7	7.9	5.1
1996	2955.2	83.6	507.8	54.4	45.6	13.1	15.4	19.9	9.3	6.7	3.1	13.6	4.1
1997	3700.9	83.7	505.5	54.7	45.3	8.5	15.5	19.1	9.0	9.0	3.8	10.8	5.1
1998	3320.4	63.5	398.7	54.4	45.6	9.4	17.6	24.1	5.5	10.4	3.1	18.0	4.8
1999	4036.6	65.5	445.3	53.6	46.4	8.6	19.1	22.5	9.7	9.1	3.4	15.7	5.8
2000	3828.4	65.6	452.6	52.5	47.5	9.2	15.1	24.0	8.8	13.3	5.6	13.7	4.1
2001	4236.5	65.2	497.7	57.7	42.3	8.9	15.6	22.5	6.6	15.5	5.7	13.8	4.7
2002	4086.7	57.4	457.7	58.4	41.6	10.8	16.6	21.6	6.3	12.9	5.2	15.2	5.2
2003	4078.3	54.3	466.8	56.3	43.7	12.2	16.3	24.1	6.2	13.8	4.0	13.8	3.9
2004	4425.4	56.6	482.2	47.7	52.3	10.1	16.3	20.6	5.8	12.6	4.4	6.0	3.0

Source: National Agricultural Production Cost Survey.

Appendix Table 14: Yield, Total Cost and Major Cost Shares for **Mandarin Orange (Guanggan)** Production

Year	Yield (kg/mu)	Output per man day (kg)	Total Production Cost (yuan/ton)	Of Total Cost (%)					Of Total Material Input Cost (%)				
				Labour Input	Materials Input	Seeds Input	Organic Manure	Fertilizer Use	Plastic Sheet	Pestici des	Irrigati on	Fence	Deprec iation
1985	1463	13	427.0	39.5	60.5	0.0	33.1	18.5	0.0	17.7	1.2	0.0	7.0
1986	1155	12	362.1	37.9	62.1	0.0	30.7	17.1	0.0	18.5	1.3	0.0	9.5
1987	1569	16	455.8	37.6	62.4	0.0	37.4	14.2	0.0	20.9	0.9	0.0	6.2
1988	995	11	424.9	35.1	64.9	0.0	34.5	13.1	0.0	24.2	1.0	0.0	7.6
1989	1585	16	471.9	33.7	66.3	0.0	22.7	22.6	0.0	28.8	0.9	0.0	8.1
1990	-	-	-	-	-	-	-	-	-	-	-	-	-
1991	1379	16	410.4	34.7	65.3	0.0	14.1	33.3	6.4	20.0	0.9	0.4	9.2
1992	1492	19	400.7	37.1	62.9	0.0	8.6	36.5	2.3	22.3	1.5	0.6	12.2
1993	1280	21	346.9	34.5	65.5	1.5	13.2	33.1	3.4	28.0	1.8	0.4	3.9
1994	1165	22	281.8	45.8	54.2	0.6	17.5	36.9	1.2	19.3	2.3	0.2	4.6
1995	1136	22	316.6	41.2	58.8	0.4	12.4	33.0	0.0	19.5	1.7	0.4	8.5
1996	1131	23	372.8	43.7	56.3	2.7	12.0	36.0	0.1	17.6	1.4	0.5	5.3
1997	1540	29	358.1	47.3	52.7	0.1	19.3	38.8	0.1	19.4	1.6	0.1	2.0
1998	1292	22	386.1	51.9	48.1	2.0	16.1	40.2	3.3	29.6	1.0	0.2	3.0
1999	1731	38	340.7	48.5	51.5	1.6	14.0	43.8	0.3	30.2	1.8	0.1	4.1
2000	1383	32	338.5	47.2	52.8	1.3	21.4	37.0	1.3	28.7	2.0	0.0	4.4
2001	1699	39	374.8	45.3	54.7	0.6	19.0	32.7	0.6	26.4	1.9	0.0	8.5
2002	1601	26	570.6	46.0	54.0	0.3	21.0	36.8	0.6	26.4	1.1	0.0	8.8
2003	2387	34	702.8	41.2	58.8	0.2	12.7	42.9	0.2	24.7	2.0	0.0	8.5

Source: National Agricultural Production Cost Survey.

Appendix Table 15: Yield, Total Cost and Major Cost Shares for **Orange (Juzi)** Production

Year	Yield (kg/mu)	Output per man day (kg)	Total Production Cost (yuan/ton)	Of Total Cost (%)					Of Total Material Input Cost (%)				
				Labour Input	Materials Input	Seeds Input	Organic Manure	Fertilizer Use	Plastic Sheet	Pestici des	Irrigati on	Fence	Deprec iation
1985	1348	16	282.0	45.0	55.0	0.0	19.1	2.3	0.0	12.9	3.9	0.0	5.8
1986	-	-	-	-	-	-	-	-	-	-	-	-	-
1987	-	-	-	-	-	-	-	-	-	-	-	-	-
1988	946	12	307.8	41.2	58.8	0.0	40.4	4.8	0.0	20.8	0.8	0.0	8.6
1989	1902	19	420.7	38.0	62.0	0.0	13.2	30.4	0.0	23.8	1.0	0.0	7.6
1990	-	-	-	-	-	-	-	-	-	-	-	-	-
1991	1823	27	319.1	36.0	64.0	0.1	9.5	31.9	1.2	24.9	0.4	0.0	9.5
1992	1751	24	396.8	35.0	65.0	1.6	12.3	27.4	0.0	19.1	2.5	0.0	9.0
1993	1963	23	396.8	43.1	56.9	0.7	10.7	29.0	0.1	33.6	1.4	0.5	4.3
1994	1673	24	360.3	51.0	49.0	1.0	12.8	31.9	0.0	24.9	0.7	0.3	5.6
1995	2035	29	350.3	50.1	49.9	2.8	5.3	36.3	0.6	22.3	1.3	0.2	3.0
1996	1557	29	381.0	51.6	48.4	0.9	4.2	45.0	0.1	25.9	1.0	0.1	8.0
1997	1963	45	260.6	53.1	46.9	0.2	10.3	35.6	0.4	26.3	9.8	0.3	5.8
1998	1239	43	181.1	50.6	49.4	2.3	14.5	44.3	0.1	23.0	1.1	0.7	6.2
1999	1676	33	425.6	49.4	50.6	1.1	14.8	38.6	0.8	33.2	0.4	0.0	6.7
2000	1193	32	255.1	54.7	45.3	0.2	16.8	38.1	0.0	30.4	2.1	0.0	7.2
2001	1240	32	332.2	50.0	50.0	7.7	11.8	35.0	0.0	33.9	1.0	0.1	6.4
2002	1521	37	380.8	49.0	51.0	0.6	15.6	37.2	0.0	35.8	0.4	0.0	6.5
2003	1819	42	383.2	52.4	47.6	0.4	14.0	40.7	0.0	35.2	0.4	0.0	4.9

Source: National Agricultural Production Cost Survey.

Appendix Table 16: Yield, Total Cost and Major Cost Shares for **Backyard Hog** Production

Year	Yield (kg/per animal)	Output per man day (kg)	Total Production Cost (yuan/ton)	Of Total Cost (%)				Of Total Material Input Cost (%)		
				Labour Input	Materials Input	Baby animal	Fine feed	fodder	Feed process	depreci ation
1985	112.3	5.3	190.9	16.9	83.1	25.0	44.6	18.9	5.9	1.4
1986	109.2	5.2	194.7	16.4	83.6	19.7	50.1	18.7	5.3	1.6
1987	106.7	4.9	218.5	19.5	80.5	20.5	48.0	20.6	5.2	1.8
1988	121.1	5.4	271.5	15.8	84.2	24.8	52.2	13.8	2.7	1.2
1989	112.5	6.0	247.9	12.4	87.6	24.8	52.2	13.8	1.8	1.2
1990	114.1	5.3	224.5	17.9	82.1	24.3	50.9	15.0	1.5	1.4
1991	112.5	6.2	224.4	16.7	83.3	26.8	51.7	13.1	1.2	1.4
1992	116.1	6.0	214.7	19.1	80.9	27.6	49.4	12.9	1.7	1.3
1993	109.2	6.4	202.9	16.5	83.5	25.6	53.3	11.3	1.5	1.4
1994	106.6	5.2	255.1	19.4	80.6	27.1	53.2	10.9	1.5	1.2
1995	107.0	6.1	267.6	15.7	84.3	25.3	57.8	9.6	1.1	1.0
1996	105.3	8.3	229.2	15.7	84.3	26.8	54.4	10.5	1.0	1.2
1997	109.2	6.4	246.7	20.0	80.0	33.1	47.1	10.9	1.8	1.1
1998	109.2	7.1	227.5	20.0	80.0	29.7	50.9	11.1	1.6	1.2
1999	105.1	7.7	182.8	22.6	77.4	23.3	55.0	12.1	1.5	1.6
2000	105.9	8.3	179.3	21.5	78.5	27.4	52.1	11.3	1.6	1.5
2001	107.6	8.3	187.2	22.5	77.5	28.2	52.4	10.4	1.4	1.8
2002	105.5	9.1	178.6	21.6	78.4	27.0	54.6	9.5	1.4	1.7
2003	106.7	8.8	192.1	21.6	78.4	26.5	56.2	9.3	1.5	1.3
2004	107.4	9.7	230.6	18.9	81.1	31.2	53.1	8.2	1.2	1.1

Source: National Agricultural Production Cost Survey.

Appendix Table 17: Yield, Total Cost and Major Cost Shares for **Specialized Hog** Production

Year	Yield (kg/per animal)	Output per man day (kg)	Total Production Cost (yuan/ton)	Of Total Cost (%)			Of Total Material Input Cost (%)			
				Labour Input	Materials Input	Baby animal	Fine feed	fodder	Feed process	depreciation
1985	95.7	9.5	143.4	11.2	88.8	27.1	54.1	9.8	2.6	1.8
1986	95.7	10.4	156.8	8.7	91.3	23.7	58.3	9.4	2.2	1.8
1987	94.8	12.0	175.9	9.8	90.2	24.3	56.3	9.9	1.8	2.2
1988	106.4	7.9	233.1	11.0	89.0	19.2	42.5	7.0	1.1	1.5
1989	105.7	10.0	195.3	9.1	90.9	23.8	50.3	7.7	0.9	1.7
1990	105.1	13.8	187.7	7.4	92.6	27.1	56.0	8.2	0.8	1.8
1991	102.1	20.1	194.4	5.4	94.6	31.4	50.8	7.2	0.6	1.7
1992	107.4	11.3	197.7	10.1	89.9	28.6	54.3	6.5	0.9	2.3
1993	101.4	11.9	178.5	9.4	90.6	25.6	56.7	6.6	1.1	2.6
1994	94.2	10.9	229.2	9.3	90.7	28.6	57.5	3.5	0.8	1.4
1995	103.7	13.1	247.1	7.3	92.7	25.8	59.5	6.6	0.7	1.4
1996	103.0	15.1	229.5	8.8	91.2	28.0	58.5	6.0	0.4	1.5
1997	104.8	16.4	237.3	8.5	91.5	36.9	50.3	5.1	0.8	1.5
1998	99.8	21.7	204.1	6.9	93.1	29.0	61.2	2.8	0.8	2.1
1999	96.1	22.2	162.6	8.8	91.2	25.1	62.5	4.7	0.8	1.9
2000	101.7	16.4	156.4	12.2	87.8	28.8	56.0	7.2	0.9	1.6
2001										
2002	95.8	21.3	153.8	9.3	90.7	27.2	59.9	4.9	1.1	1.7
2003	98.9	16.8	170.3	11.8	88.2	26.7	61.5	4.7	1.1	1.5
2004	102.5	18.4	217.9	10.6	89.4	31.2	57.8	3.7	0.8	1.5

Source: National Agricultural Production Cost Survey.

Appendix Table 18: Yield, Total Cost and Major Cost Shares for **State-Collective** Hog Production

Year	Yield (kg/per animal)	Output per man day (kg)	Total Production Cost (yuan/ton)	Of Total Cost (%)			Of Total Material Input Cost (%)			
				Labour Input	Materials Input	Piglet	Fine feed	fodder	Feed process	depreciation
1985	105.4	12.2	186.2	8.8	91.2	28.1	55.9	8.4	1.4	1.9
1986	107.7	14.6	217.1	6.6	93.4	31.1	56.1	5.3	1.0	1.7
1987	110.7	19.7	255.1	4.7	95.3	33.6	56.2	2.7	0.7	1.6
1988	113.0	26.2	247.9	3.7	96.3	34.8	56.3	1.4	0.5	1.5
1989	98.7	28.0	214.9	2.7	97.3	34.8	56.3	1.4	0.5	1.5
1990	99.7	29.5	201.7	3.2	96.8	30.4	58.5	1.9	0.5	1.7
1991	96.6	32.3	197.4	3.3	96.7	38.7	50.3	1.5	0.7	1.5
1992	103.8	16.6	214.6	6.3	93.7	28.1	59.3	2.1	0.3	2.3
1993	105.0	20.0	187.4	5.5	94.5	20.6	67.7	0.9	0.4	2.3
1994	95.3	16.0	228.7	7.5	92.5	23.2	63.2	3.3	0.5	1.8
1995	99.5	16.5	255.0	6.8	93.2	25.2	63.0	3.0	0.3	1.8
1996	98.0	16.9	253.6	7.7	92.3	24.1	64.1	0.6	0.5	2.2
1997	96.2	18.2	257.4	7.7	92.3	31.9	56.8	0.9	0.4	2.2
1998	94.4	23.4	212.0	6.7	93.3	29.7	59.4	2.6	0.7	2.5
1999	94.1	48.3	173.7	4.2	95.8	28.9	61.0	0.8	0.6	3.0
2000	97.6	28.6	165.6	7.0	93.0	26.9	61.4	3.0	0.8	2.6
2001	97.8	36.7	172.2	5.4	94.6	28.4	61.9	1.8	0.8	2.0
2002	96.2	42.3	162.6	5.6	94.4	28.1	62.6	1.3	0.7	2.2
2003	98.2	42.6	178.1	5.1	94.9	28.3	63.2	1.2	0.7	1.9
2004	100.3	44.4	220.4	5.7	94.3	31.8	59.0	1.4	0.7	1.6

Source: National Agricultural Production Cost Survey.

Appendix Table 19: Yield, Total Cost and Major Cost Shares for **Special Household egg** Production

Year	Yield (kg/100 heads)	Output per man day (kg)	Total Production Cost (yuan/ton)	Of Total Cost (%)			Of Total Material Input Cost (%)			
				Labour Input	Materials Input	Animal	Fine feed	fodder	Feed process	depreciation
1991	1256	13.9	2641.1	5.8	94.2	15.6	71.8	0.3	1.0	3.2
1992	1022	12.0	2484.9	6.4	93.6	16.8	68.5	3.2	0.5	3.3
1993	1226	19.3	2534.1	4.9	95.1	13.9	73.0	0.9	0.6	3.2
1994	1260	23.2	2501.0	4.5	95.5	10.4	80.0	0.2	0.5	2.4
1995	1350	31.0	2730.9	3.3	96.7	11.4	80.4	0.2	0.3	1.8
1996	1357	31.5	2390.1	4.6	95.4	9.3	82.6	0.8	0.5	1.6
1997	1448	39.9	2570.4	3.9	96.1	13.6	76.3	0.4	0.6	1.8
1998	1535	42.0	2454.3	4.5	95.5	13.9	79.5	0.2	0.7	1.5
1999	1463	50.5	2014.3	4.3	95.7	13.6	79.2	0.8	0.7	1.2
2000	1487	58.1	1962.6	3.9	96.1	20.5	73.3	0.2	0.7	1.4
2001	1545	60.4	2015.0	4.0	96.0	21.1	72.9	0.2	0.6	1.5
2002	1570	68.6	2055.3	3.8	96.2	19.6	73.7	0.1	0.6	1.7
2003	1551	68.6	2195.0	3.7	96.3	17.8	75.9	0.1	0.2	1.6
2004	1604	54.5	2360.7	4.9	95.1	20.5	75.3	0.0	0.3	0.9

Source: National Agricultural Production Cost Survey.

Appendix Table 20: Yield, Total Cost and Major Cost Shares for **State-Collective egg** Production

Year	Yield (kg/100 heads)	Output per man day (kg)	Total Production Cost (yuan/ton)	Of Total Cost (%)			Of Total Material Input Cost (%)			
				Labour Input	Materials Input	Animal	Fine feed	fodder	Feed process	Depreciation
1991	1222	35.3	2637.0	2.2	97.8	19.9	64.8	0.6	0.4	4.6
1992	1256	33.2	3016.5	2.3	97.7	17.6	65.5	2.3	0.4	3.8
1993	1232	35.9	2856.5	2.4	97.6	12.5	73.7	0.1	1.2	2.8
1994	1426	36.2	3008.9	3.6	96.4	14.2	72.7	0.0	0.1	2.8
1995	1425	52.4	3228.5	2.5	97.5	12.7	76.7	1.2	0.2	2.0
1996	1481	58.8	3185.0	2.5	97.5	12.2	77.6	0.6	0.8	2.3
1997	1445	56.8	2716.6	3.3	96.7	15.3	73.8	0.1	1.1	2.4
1998	1469	58.3	2727.4	3.3	96.7	18.0	73.5	0.3	0.6	2.0
1999	1495	57.3	2318.0	4.3	95.7	20.4	70.5	0.0	0.6	2.7
2000	1523	77.3	2263.9	3.2	96.8	16.2	73.5	0.3	0.6	3.1
2001	1541	89.0	2273.8	3.1	96.9	19.0	72.5	0.0	0.5	2.7
2002	1581	114.6	2213.1	2.4	97.6	17.9	74.0	0.1	0.7	2.7
2003	1611	109.6	2437.6	2.5	97.5	18.4	73.4	0.0	1.0	2.6
2004	1600	95.4	2492.4	3.7	96.3	19.6	75.3	0.0	0.3	1.4

Source: National Agricultural Production Cost Survey.

Table 21: Yield, Total Cost and Major Cost Shares for **Beef Cattle** Production

Year	Yield (kg/100 heads)	Output per man day (kg)	Total Production Cost (yuan/ton)	Of Total Cost (%)			Of Total Material Input Cost (%)			
				Labour Input	Materials Input	animal	Fine feed	fodder	Feed process	depreciation
1985	218	2.8	528.1	22.6	77.4	55.4	15.9	0.0	0.0	0.0
1986	244	3.4	515.1	19.6	80.4	60.7	16.2	0.0	0.0	0.0
1987	256	4.6	489.5	20.7	79.3	66.7	16.5	0.0	0.0	0.0
1988	285	4.1	486.2	28.4	71.6	65.5	16.5	0.0	0.0	0.0
1989	297	5.9	395.5	20.7	79.3	64.5	16.4	11.0	0.6	3.9
1990	320	5.7	422.9	23.5	76.5	59.9	14.0	17.8	0.8	2.8
1991	366	7.7	484.0	16.7	83.3	73.6	11.1	10.9	0.5	1.7
1992	268	5.2	432.0	22.2	77.8	66.0	15.1	12.4	0.8	2.1
1993	330	6.9	429.0	22.1	77.9	65.3	14.3	11.4	1.2	3.2
1994	359	6.2	635.7	18.0	82.0	63.7	17.1	10.8	1.1	1.9
1995	370	7.6	553.6	17.3	82.7	50.4	25.6	11.0	1.1	3.2
1996	317	7.8	536.7	16.8	83.2	56.6	21.4	12.4	1.3	2.5
1997	360	10.2	451.4	20.0	80.0	61.1	18.6	11.0	1.5	3.1
1998	336	12.0	444.8	16.9	83.1	60.0	18.7	13.2	1.2	3.7
1999	356	11.5	514.8	16.4	83.6	63.5	16.5	8.9	0.8	2.3
2000	339	18.1	448.2	11.7	88.3	66.2	16.2	12.3	0.8	1.9
2001	350	15.3	463.3	13.5	86.5	66.6	18.5	10.0	0.8	1.6
2002	351	14.1	524.4	14.1	85.9	69.1	17.2	8.8	0.8	1.9
2003	379	12.4	592.0	15.7	84.3	69.0	18.2	7.7	0.7	2.0
2004	350	15.2	538.1	17.0	83.0	63.2	21.3	9.8	0.8	1.7

Source: National Agricultural Production Cost Survey.

Appendix Table 22: Yield, Total Cost and Major Cost Shares for **Special Household Milk** Production

Year	Yield (kg/100 heads)	Output per man day (kg)	Total Production Cost (yuan/ton)	Of Total Cost (%)		Of Total Material Input Cost (%)				
				Labour Input	Materials Input	animal	Fine feed	fodder	Feed process	depreciation
1992	4335	42.2	1621.6	11.8	88.2	11.0	50.1	22.3	0.7	4.0
1993	4234	32.4	1700.0	15.1	84.9	10.7	54.2	20.5	1.5	2.5
1994	5159	48.5	1842.9	12.2	87.8	9.6	61.1	17.7	0.4	3.1
1995	4998	41.1	2039.5	11.5	88.5	7.2	64.9	19.3	0.4	1.8
1996	4705	64.9	1852.8	10.2	89.8	8.7	66.7	17.6	0.4	1.7
1997	5071	60.4	2344.2	10.3	89.7	6.8	50.2	22.5	0.6	4.5
1998	4602	65.7	1794.1	11.6	88.4	9.9	57.6	18.9	0.6	2.9
1999	4421	67.1	1690.6	11.0	89.0	8.3	62.7	15.9	0.8	3.5
2000	5032	64.4	1802.7	12.8	87.2	11.6	56.6	16.5	0.7	5.7
2001	5121	78.4	1910.1	10.7	89.3	11.6	58.9	16.5	0.4	5.0
2002	5226	68.4	2131.0	11.4	88.6	10.9	58.7	16.7	0.5	4.6
2003	5342	88.4	2120.0	10.0	90.0	11.8	58.8	18.0	0.4	4.0
2004	5159	109.6	2438.7	9.5	90.5	9.9	49.1	15.2	0.6	17.9

Source: National Agricultural Production Cost Survey.

Appendix Table 23: Yield, Total Cost and Major Cost Shares for **State-Collective Milk** Production

Year	Yield (kg/100 heads)	Output per man day (kg)	Total Production Cost (yuan/ton)	Of Total Cost (%)		Of Total Material Input Cost (%)				
				Labour Input	Materials Input	animal	Fine feed	fodder	Feed process	depreciation
1992	4744	35.9	2204.3	11.2	88.8	7.9	40.0	22.8	0.5	5.8
1993	4736	49.0	2233.9	8.5	91.5	6.8	45.8	23.0	0.2	4.5
1994	4477	47.8	2333.2	10.1	89.9	4.6	50.8	20.2	0.1	4.8
1995	4757	60.9	2711.0	8.2	91.8	6.5	52.4	20.0	0.2	5.0
1996	5139	55.1	3002.9	9.9	90.1	5.1	47.9	22.1	0.6	4.4
1997	5155	63.8	2775.7	9.3	90.7	5.0	47.2	23.8	0.8	5.2
1998	5435	86.9	2790.4	7.7	92.3	4.6	45.1	25.3	0.4	6.4
1999	5889	89.9	2890.0	8.2	91.8	7.9	43.1	26.2	0.5	6.4
2000	6019	92.9	3041.7	7.4	92.6	8.3	41.6	24.0	0.4	7.4
2001	6000	93.5	3006.4	6.7	93.3	6.4	44.2	25.1	0.4	8.7
2002	6032	93.7	3035.6	8.0	92.0	7.4	41.4	24.7	0.8	10.4
2003	6091	97.6	3227.0	7.6	92.4	7.5	44.1	24.3	0.6	8.8
2004	5868	139.0	3107.4	9.9	90.1	7.9	45.8	23.0	0.5	13.6

Source: National Agricultural Production Cost Survey.

Endnotes

ⁱ See Kumbhakar and Lovell (chapter 7), and Cuesta for a review of recent approaches to the incorporation of exogenous influences on technical inefficiency.

ⁱⁱ The cost and return survey did not contain egg yields for every province for each of the past 15 years. Provincial trend regressions were used to estimate yields in such cases.

ⁱⁱⁱ Data on inventories of breeding broilers are available only from 1998, and we could not discover any way of deriving earlier data from the available poultry statistics. This severely limited our ability to analyse productivity developments in this sector.

^{iv} This survey is conducted through a joint effort of the State Development Planning Commission, the State Economic and Trade Commission, the Ministry of Agriculture, the State Forestry Administration, the State Light Industry Administration, the State Tobacco Administration and the State Supply and Marketing Incorporation.

^v We did not disaggregate beef data by farm type, since the cost survey presented beef information for just a single category – rural households.